Chapter 5.
RIVER DIATOM INDEX

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INTRODUCTION

Although much is known about diatom responses to human-induced degradation, relatively little work has been done, compared to fish and invertebrates, to formalize this knowledge in terms of a monitoring tool for biological assessment of lotic waters, (Rosen 1995, Whitton and Kelly 1995, Davis et al.1996, Hill et al. 2000). This situation is changing rapidly as European countries develop indexes to monitor eutrophication (Kelly and Whitton, 1998) and US monitoring programs incorporate algal sampling into their routine assessments (Rosen 1995, Charles 1996).

The importance of algae to riverine ecology is easily appreciated when one considers their role as primary producers that transform solar energy into food for many invertebrates (Lamberti 1996). In addition, algae transform inorganic nutrients, such as atmospheric nitrogen, into organic forms, such as ammonia and amino acids, that can be used by other organisms (Mulholland 1996). Structurally, algae stabilize the substrate and create mats that form habitat for fish and invertebrates. Some invertebrates use algae to construct cases (Bott 1996).

Algal monitoring has evolved from the early indexes of saprobity (Reid et al. 1995, Lowe and Pan 1996) developed for European streams into a variety of tolerance indexes related to specific stressors (Prygiel and Coste 1993, Kelly and Whitton 1998, Stevenson and Pan 1999). Many studies have linked changes in algal assemblages, particularly diatoms, to changes in water chemistry such as pH, phosphorus, and nitrogen (Carrick, Lowe, and Rotenberry 1988, Pan et al. 1996, Winter and Duthie 2000). Water chemistry variables are meaningful proxy measures for human disturbance in some cases, for example, when nutrient enrichment results from agriculture (McCormick and O'Dell 1996, Pan et al. 1996). For other types of disturbances, chemistry may fail to capture changes associated with loss of instream or riparian vegetation, increased sunlight, or alteration of the flow regime (Barbour, Stribling, and Karr 1995, Karr, Allan and Benke in press). Consequently, other studies have taken a broader view of human influence and tested algal response to more direct measures of human disturbance such as catchment land cover, land use and riparian disturbance (Kutka and Richards 1996, Chessman et al. 1999, Pan et al. 1999, Hill et al. 2000).

The purpose of this study was to determine which attributes of the diatom assemblage were consistently associated with human disturbance, either at the site or catchment scale. We selected diatoms because they dominate algal assemblages in Idaho, are relatively easy to

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identify to species and because much is known about their natural history (Van Dam, Mertens and Sinkeldam 1994, Stevenson and Pan 1999). Our goal was to develop a multimetric index (Karr et al. 1986, Stevenson and Bahls 1999) for diatoms to use alongside similar indexes for fish and invertebrates to assess the biological condition of Idaho rivers under the CWAct (Karr 1991, Ransel 1995, Mebane, 2000).

METHODS

We followed four steps in developing and testing a multimetric index (RDI) for Idaho rivers. First, we defined three geographic regions based on physical features and types of human disturbance. Second, we either ranked sites according to the intensity of human disturbance (southern sites) or we grouped sites according to the type of disturbance (northern sites). Third, we tested metrics in each region and selected metrics that were not redundant to be included in a multimetric index. Last, we evaluated the index in terms of its statistical precision and association with disturbance.

Periphyton Collection and Identification

Periphyton were collected from 49 river sites on 23 rivers from mid-August through late October (typically baseflow period) in 1997 and 1998 (Figure 5-1). In 1999, eight sites were selected for repeat sampling and were sampled twice on the same day in September and once again one month later.

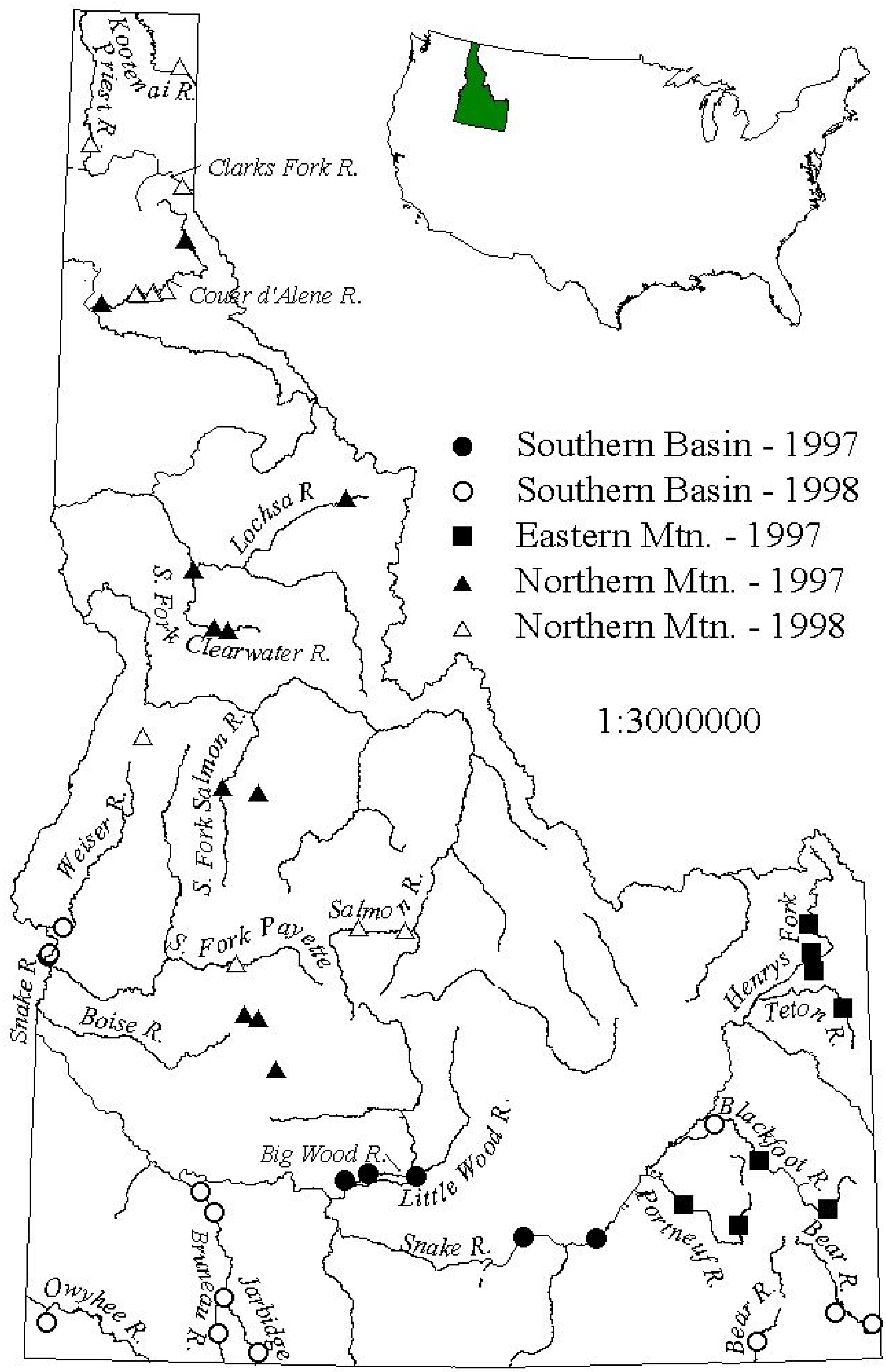

Figure 5-1. River sampling sites, year sampled and geographic region.

Field crews collected periphyton from riffle habitat at three transects located 200 to 300 m apart depending on channel width. Three rocks were collected from each transect at the right, left and center of each transect, for a total of nine rocks. For very deep sites, rocks were collected closer to the river bank. For same-day samples, crew members sampled from the same transect locations, but selected rocks separately. Periphyton were sampled with a brush and syringe from each of the nine rocks and combined for a total sample area of approximately 28 cm^2 (Porter et al. 1993). Samples were preserved with two percent formalin.

In the laboratory, samples were cleaned using nitric acid digestion and a microwave apparatus before slide mounting with Naphrax™. A minimum of 800 valves were counted at 1000x magnification and identified to the level of species where possible. Soft algae were identified in 1997 and 1999 to the level of genus.

Geographic Classification of Sites

We classified sites according to landscape features because human activities followed topography (Omernik and Gallant 1986). We grouped sites from similar ecoregions (Omernik 1995) into three geographic regions: southern basins (18 sites), eastern mountains (eight sites), and northern mountains (23 sites). Southern basins (SB) included 14 sites from the Snake River Basin/High Desert, two from the Wyoming Basin, and two from the Northern Basin and Range. Eastern mountains (EM) and northern mountains (NM) sites were all located in the Northern Rockies ecoregion except for one site in the Middle Rockies. We split this ecoregion into two groups because of the differences in latitude, land cover, and land use. Compared to SB and EM sites, NM sites had less urbanization and agriculture, higher forest cover, and lower temperatures. EM sites had to higher forest cover and higher elevation than SB sites, although intensities of agriculture and urbanization were similar.

Quantifying Human Disturbance

Human disturbance was measured at three spatial scales: the sample reach, 10 km upstream from the site, and the catchment. Measurements at the stream reach included percent erosion; percent fines; and, for riparian vegetation, extensiveness, condition, and predominant type of vegetation on each bank. Chemical variables included temperature, dissolved oxygen, conductivity, and pH. We used principal components analysis to reduce these 12 related measures to a single measure of site condition (PC1-HAB). At a larger scale, field crews noted the types of human activities in an approximate 10 km radius upstream. They also contacted regional land managers to confirm their observations and identify other important activities they might have missed. Activities including forestry, mining, agriculture, grazing, urbanization, channel alteration, and recreation and were noted near the site and further upstream. We summed the number of activities observed as a measure of the intensity of human disturbance.

Satellite data were used to estimate the percent of the catchment area upstream of each site classified as agricultural, developed for urban use, forested, or rangeland. These large river sites had potentially huge land areas in their upstream catchments; therefore, we based calculations on the 4th level hydrologic unit as defined by the USGS (Seaber et al. 1987) rather than the entire upstream catchment. If a site was near the unit boundary, the next upstream unit was also included. The average area upstream used for calculation was approximately 2300 km^2. Although grazing is associated with rangeland, the area of the catchment defined as range was not an indication of grazing intensity. Livestock grazing is an important activity in Idaho and can be very destructive to water resources (Fleischner 1994), but could not be quantified for this study. Similarly, forested area only measured vegetation cover and did not distinguish forest type based on stand age or crown cover.

Identifying Candidate Diatom Metrics

For this study, we distinguished between the terms attribute, candidate metric, and metric. Attribute refers to any feature of the algal assemblage (e.g., diatoms) that is tolerant of polysaprobic conditions. Candidate metric refers to the way in which an attribute is measured (e.g., percent relative abundance of polysaprobic valves). Metrics are promoted from candidacy if they demonstrate a significant correlation with human disturbance. Most attributes could be expressed in more than one way, for example, as taxa richness or percent relative abundance. Percents (e.g., percent motile valves), were calculated as the number of valves in the group of interest, divided by the total number of valves identified. In addition, some candidate metrics were tested for both species and genus-level identification. Thus, 26 attributes were selected from the literature, 55 candidate metrics were tested, and 12 metrics were selected for possible inclusion in the final index.

We tested attributes related to tolerance and intolerance, autecological guild, community structure, morphological guild, and individual condition (Table 5-1).

Table 5-1. Diatom attributes, their predicted response to human disturbance, results of five tests for association with disturbance and level of taxonomic identification used to calculate.
For autecological guild, only the general attribute is listed because significance for number of taxa and percent of valves were typically similar. Metrics considered for inclusion in RDI are underlined. We used Spearman's *r* to test EM and 1998 SB sites; for 1997 SB sites, "agree" indicates $r > 0.6$; and we used the Mann-Whitney U-test for NM sites. (All tests were one-sided; * $P < 0.05$; * $P < 0.025$. Significant results in the *opposite* direction of prediction are marked with an '*X*'.)

Diatom attribute	Predicted response	EM 1997 n=8	SB 1998 n=13	SB 1997 n=5	NM Dist n=10, 6	NM Mining n=10, 7	Level of ID
Tolerance and Intolerance							
Pollution tolerance index [1, 2]	Decrease	* *				* *	Species
% Sensitive individuals [1, 2]	Decrease	* *	*			* *	Species
		*	* *				Genus
No. of sensitive species [1, 2]	Decrease	*				* *	Species
% Tolerant individuals [1, 2]	Increase	* *	*			* *	Species
No. of tolerant species [1, 2]	Increase	*	*				Species
% Very tolerant individuals [1]	Increase	* *	* *	*agree*		* *	Species

Diatom attribute	Predicted response	EM 1997 n=8	SB 1998 n=13	SB 1997 n=5	NM Dist n=10, 6	NM Mining n=10, 7	Level of ID
No. of very tolerant species[1]	Increase		* *	*agree*		* *	Species
Salinity tolerance [3]	Increase	*				*X*	Species
Autecological Guild							
Eutrophic [3, 4]	Increase	*	* *	*agree*	*		Species
	Increase		* *	*agree*		*X*	Genus
Oligotrophic [3]	Decrease					*X*	Species
Nitrogen fixers [5]	Decrease					* *	Genus
Nitrogen heterotrophs [3]	Increase	*	* *	*agree*		*	Species
			*	*agree*			Genus
Polysaprobic [3]	Increase	* *	* *	*agree*	*	* *	Species
Oligosaprobic [3]	Decrease	*				* *	Species
Alkaliphilic [3]	Increase		* *	*agree*	*	*X*	Species
			* *	*agree*			Genus
Require high oxygen [3]	Decrease	*	* *	*agree*	*X*		Species
		* *	*				Genus
Tolerate low oxygen [3]	Increase	* *	*	*agree*		* *	Species
Community Structure							
Total taxa richness [2]	Decrease		*X*	*X*		* *	Species
Diversity index [2]	Decrease					* *	Species
% Dominance (1-5 taxa) [2, 4]	Increase		*X*			* *	Species
Percent *Ach. minutissima* [2]	Increase					* *	Species
Morphological Guilds							
% Motile [1]	Increase	* *	* *	*agree*			Genus
% Moderately motile [6]	Increase	*					Genus
% Very motile [6]	Increase	*	* *	*agree*	*		Genus
% Prostrate [6]	Increase		* *				Genus
% Erect [6]	Decrease			*X*		*X*	Genus
% Stalked [6]	Decrease		* *			* *	Genus
% Unattached [6]	Increase						Genus
Individual condition							
% Deformed cells	Increase					* *	None

Tolerance and intolerance

Species were categorized as sensitive, tolerant or very tolerant according to Bahls (1993), who modified initial assignments by Lange-Bertalot (1979) and Lowe (1974) to reflect diatom responses to disturbance in Montana. Diatom species were defined as generally tolerant to high nutrients (eutrophic), organics (polysaprobic), temperature (euthermal), salts (euhalobus), toxics, suspended solids, or unstable substrate (Bahls 1993).

The pollution tolerance index (PTI) was calculated as the sum over all taxa of the number of valves within each species multiplied by that species' tolerance value. This format is typical for many algae indexes used in Europe (Whitton and Kelly 1995).

Autecological Guilds

Diatom samples from Idaho rivers included taxa listed as tolerant to salt by Van Dam et al. (1994). Evaporation of irrigation water from agricultural fields can leave salt or alkaline residue that is washed into the river by precipitation or irrigation return. We predicted salt tolerant species and relative abundance of salt tolerant valves would increase with agriculture and livestock grazing.

A trophic state refers to the presence of inorganic nutrients such as nitrogen, phosphorus, silica, and carbon; in contrast, saprobity refers to the presence of biodegradable organic matter and high oxygen concentrations (Van Dam et al. 1994). We expected eutrophic and polysaprobic diatoms to increase if inorganic or organic nutrients were present in large amounts. Fertilizer from irrigated fields is one potential source of inorganic nutrient enrichment; livestock excrement and wastewater return are sources of organic waste. In contrast, oligotrophic and oligosaprobic diatoms should decline with disturbances that increase nutrient levels. Although Van Dam et al. (1994) originally classified species as tolerant or intolerant of high or low oxygen levels in the context of organic waste decomposition, this attribute may be applicable for Idaho rivers where dams create stagnate water that is poorly oxygenated.

Diatoms in the genera *Epithemia* and *Rhopalodia* are called nitrogen fixers because they harbor cyanobacteria as endosymbionts that allow them to convert atmospheric nitrogen into more biologically useful forms such as ammonia (Mulholland 1996). Diatoms classified as nitrogen heterotrophs can use amino acids created by other organisms as sources of carbon and nitrogen (Tuchman 1996). Thus, nitrogen fixers should decline and nitrogen heterotrophs should increase with disturbances that increase organic nitrogen.

Many diatoms are known to be specifically sensitive to acidic or alkaline conditions. In southern basins, agriculture on alkaline soils can cause erosion which may increase alkalinity of rivers. Irrigation and fertilization can also increase alkalinity of soils. For this type of disturbance, we expected alkaliphilic diatoms to increase. Overall, Idaho river sites tended toward alkalinity, pH values ranged from 6.5 to 9.1, and only two sites were below neutral (7.0). Consequently, acidophilic taxa may not be common in these rivers. This attribute was included for testing because of its potential sensitivity to acid mine waste.

Community Structure

Human activities that increase silt and sediment often reduce habitat complexity which can lead to a decline in biodiversity and dominance by a few tolerant taxa. Dominance was calculated as the percent relative abundance of the single most abundant species; dominance was also calculated as the sum of the two through five most abundant species present in the sample. *Achnanthes minutissima* is a common diatom associated with scouring. A high relative abundance of this species may indicate recent disturbance by extreme flows such as those caused by a dam release or excessive run-off from developed areas (Stevenson and Bahls 1999).

Morphological Structure Guilds

Motile diatoms include species that can move across unstable substrate without being buried; thus, they are somewhat tolerant of silt. We expected them to increase as sediment increased. We tested percent motile diatoms in three ways, all calculated at the genus level. We tested very motile genera (*Cymatopleura*, *Gyrosigma, Hantzschia, Nitzschia, Stenopterobia,* and *Surirella*), moderately motile genera (all genera with a raphe, excluding very motile genera), andgenera listed in Bahls' (1993) siltation tolerant index (*Navicula, Nitzschia* and *Surirella*).

Algal mats are hypothesized to follow a pattern of succession (McCormick 1996, Peterson 1996) that may begin with high spring flows carrying sediment that scour the substrate. The first algae that attach to the scoured surface attach along their length (prostrate); they are followed by algae that attach apically (adnate). Next are algae that attach perpendicular to the substrate (erect); last are the stalked and filamentous algae that are typically taller and cannot tolerate fast current (Kutka and Richards 1996). Diatom genera were assigned to morphological guilds based on how cells attach to the substrate and each other (Round et al. 1990, Stevenson 2000). Morphological attributes were only tested as percents because the physical structure of the assemblage depends more on the percent of valves of each type than the presence of a particular taxon.

Individual Condition

Cell deformities have been associated with contamination by heavy metals and should increase with this type of disturbance (McFarland, Hill, Willingham 1997). This attribute was only calculated for 1998 and 1999 samples.

Criteria for Metric Selection

Metrics selected for RDI satisfied three criteria: (1) they were significantly associated with disturbance in at least two geographic regions, (2) they responded to disturbance in the predicted direction, and (3) they were not redundant with other metrics.

For SB and EM sites, we tested for significant correlation (Spearman's r) of candidate metrics against a gradient of human disturbance measured as the total number of human activities (NUM_ACT) near the site. We selected this measures for two reasons. First, it was significantly correlated (Spearman's r, $p < 0.05$) with measures of disturbance made at the reach scale (PC1-HAB) and the catchment scale (percent agriculture, forested, and urban land cover). Second, NUM_ACT represented a compromise between site scale and catchment scale measures of human influence.

For NM sites, a gradient could not be defined for testing because the range of disturbance was not as broad as it was for SB and EM sites. Instead, we defined three site groups based on the type and intensity of disturbance and tested for significant differences between groups (Mann-Whitney U-test). The first group was made of ten sites with low, or minimal, disturbance that were influenced by timber harvest and a small amount (less than 0.4 percent) of urbanization in the catchment. The second group was moderately disturbed and included four sites with agriculture or urbanization greater than 0.4 percent, one site with very high levels of timber harvest, and one with a large hydropower facility that severely altered daily peak flows. The third group included seven sites with a history of silver mining upstream that are still contaminated by heavy metals, particularly zinc (Farag et al. 1999). Six of the seven mining sites were on the Coeur d'Alene River; therefore, the data were not independent. Consequently, significant differences should not be generalized to other rivers without additional testing.

We tested candidate metrics for their association with disturbance using five independent tests including two tests for the SB region (1997 and 1998), one test for the EM region, and two tests for the NM region (low vs. moderate disturbance and low vs. mining disturbance). We used multiple tests because some significant correlations are expected due to chance when testing a large number of hypotheses; the percent of significant results expected by chance is equal to the alpha-level of the test. Multiple, independent tests insure that observed patterns are broadly applicable and are not unique to the data set in hand. In this case, five percent of 55 tests (the number of candidate metrics tested) is approximately three, or one-quarter of the 12 metrics ultimately selected. By restricting our selection to those candidate metrics that satisfied two independent tests of significance, significance due to chance alone declines to 0.25 percent of 55, or much less than one.

We used one-sided tests in all cases because we were testing specific predictions about how diatom attributes should change in response to human disturbance. One-sided tests increased the power of the test to detect differences.

Some pairs of metrics were redundant either because they measured the same attribute or they were based on the same taxa. In each case, we selected the metric that was significant for the most tests and did not include the other metric in the index.

Constructing a Multimetric Index

Metrics were combined into an overall multimetric index, the RDI. Metrics were rescaled using scoring criteria because each metric had a different range of potential values. Scoring criteria were based on the cumulative distribution plots of metric values. We assumed that rivers sampled for this data set were evenly spread across a gradient of human disturbance and defined scoring breaks to follow the percentiles of the distributions of metric values. Our assumption may not be correct and scoring criteria should be reevaluated as more data are collected.

We scored metrics using two different sets of scoring criteria, based on three and 10 scoring categories. We compared the two versions of the RDI to determine whether the scoring method affected the precision of the index. For both versions of the RDI, larger values indicated better biological conditions.

Evaluating the Statistical Properties of the Index

Eight sites were sampled three times in 1999 and once in a previous year. For both versions of the RDI and for eight of its nine component metrics, we used an Anova model to estimate the proportion of the total variance associated with site differences, transect location within sites, and time of sampling.

Using the estimates for mean squared error from the preceding Anova models, we also estimated the number of categories of biological condition that the RDI could reliably detect based on the minimum detectable difference, or MDD (Zar 1984). We used a simple statistical model, a two-sample *t*-test with three replicates, and commonly accepted values for alpha of 0.05 and power (1 – beta) of 0.80 (Peterman 1990, Carlisle and Clements 1999). This model answers the question, "How large a difference between RDI values do we have an 80 percent chance of detecting with a p-value < 0.05?" We divided the possible range of the RDI by the MDD to obtain the number of distinct categories of biological condition the RDI could detect (Fore et al. 1994, Fore et al. in press).

RESULTS

We developed a multimetric index for periphyton based on diatoms because they dominated the field samples. We selected nine metrics for the RDI that showed a consistent association with disturbance in different regions and used species level rather than genus level identification where possible. We scored metrics based on three rather than 10 scoring categories because it was simpler and did not affect the precision of the RDI. Measurement error of the RDI and its component metrics was higher for differences associated with time rather than location of sampling. The RDI could reliably detect three levels of biological conditions based on annual sampling and may be more precise if sampling were restricted to the same month each year.

Algae Sampling

Periphyton sampling yielded 350 diatom species in 46 genera. The most abundant species, *Achnanthes minutissima*, was found at every site. Many species were rare; only a single valve was found for 11 percent of the species. For soft algae, 27 genera were identified in 1997 with *Calothrix sp*. present at the most sites. We did not test attributes based on soft algae because very few genera were collected at each site (2.7 on average) and many sites had none. Samples collected in eastern Washington showed a similar pattern where 77 to 97 percent of the taxa collected were diatoms (Cuffney et al. 1997).

Averaging across sites, about 10 species per sample, or 15 percent of the individual valves, were not listed by Van Dam et al. (1994). We did not have autecological information for these species. For SB and EM sites, neither the number of unassigned species nor the percent of unassigned valves was correlated with human disturbance. In contrast, for the NM region, significantly more unidentified species were found at less disturbed sites.

Metric Response to Disturbance

Of the 26 attributes tested, 12 were consistently associated with human disturbance across the state (see Table 5-1). Eight metrics were associated with disturbance in all three regions:

percent sensitive valves, percent tolerant valves, percent very tolerant valves, number of eutrophic species, percent nitrogen heterotrophs, percent polysaprobic valves, number of low oxygen species, and percent very motile valves. Three metrics were significantly in two regions (usually SB and EM): number of alkaliphilic species, percent high oxygen valves, and percent motile valves. For percent deformed cells, only mining sites had higher values in the NM region.

Results of testing in the EM region and for two years in the SB region tended to agree for most candidate metrics, probably because similar types of human disturbance were common in both regions. Percent sensitive and high oxygen valves declined with increasing disturbance; percent very tolerant, polysaprobic, nitrogen heterotroph, and very motile valves, and the number of alkaliphilic and eutrophic species increased with disturbance (Figure 5-2).

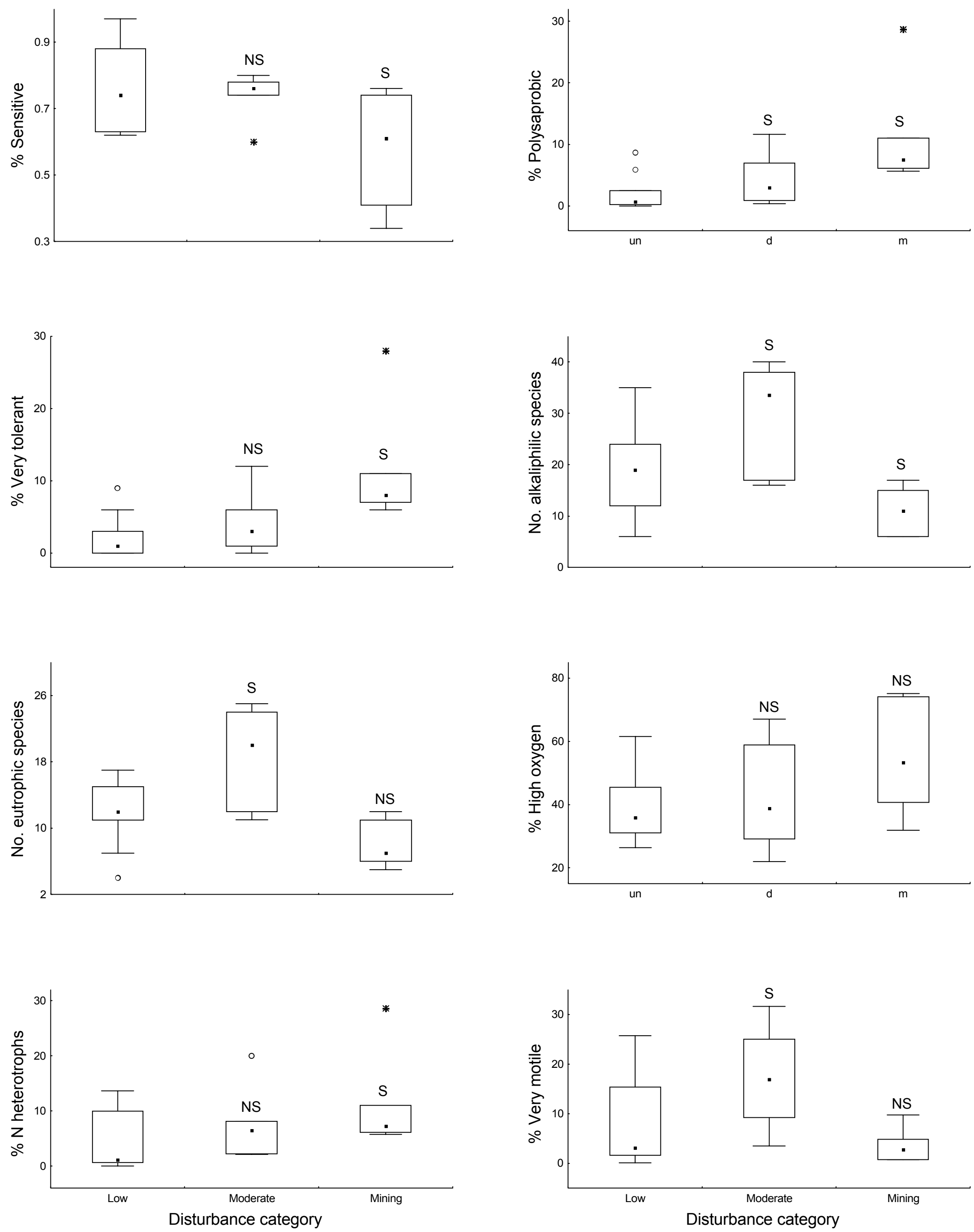

Figure 5-2. Eight diatom metrics associated with human disturbance.
Eight diatom metrics were significantly associated with human disturbance measured as the number of human activities within 10 km of the site. Least-squares regression lines drawn separately for SB (open circles) and EM (solid triangles) sites. For three metrics in the SB region, regression lines differed by year and are drawn separately for each year.

In the NM region, somewhat fewer candidate metrics were significantly associated with disturbance and those that were tended to be significantly associated with either moderate disturbance or mining disturbance, but not both (Figure 5-3). Percent sensitive valves were significantly lower, and percent polysaprobic, very tolerant, and nitrogen heterotroph valves were higher at mining sites. For moderately disturbed sites, percent polysaprobic and very motile valves and number of eutrophic species increased with disturbance. The number of alkaliphilic species was significantly higher for moderately disturbed sites (as predicted), but significantly lower for mining sites, probably due to acidic mine waste.

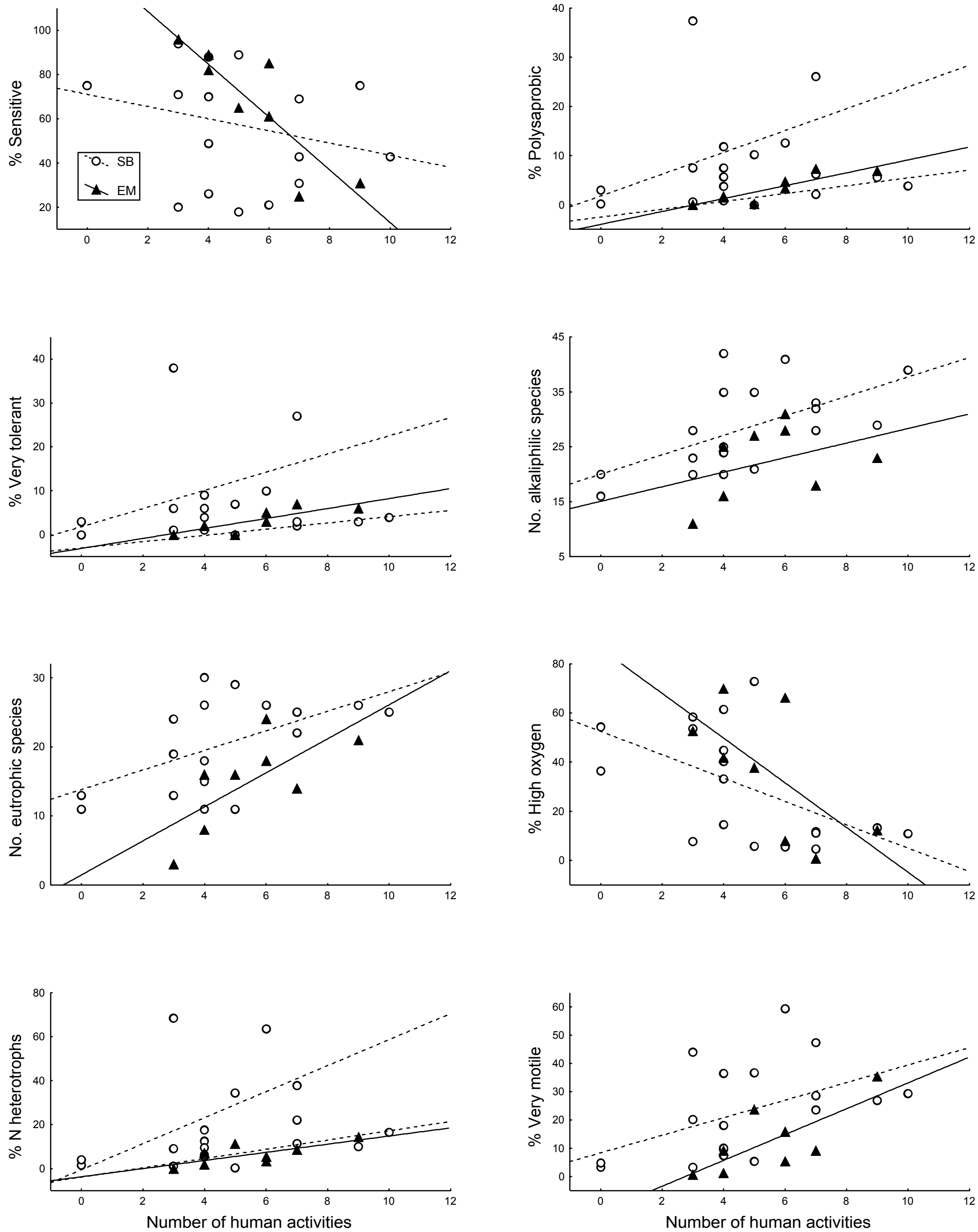

Figure 5-3. Comparison of eight metrics for groups of sites classified as low human disturbance, moderate disturbance and mining disturbance in the NM region.
The outlier in the mining group for percent very tolerant, nitrogen heterotrophs and polysaprobic was a site just downstream of a wastewater treatment plant. Boxes marked with an "S" were significantly different from the low disturbance groups; "NS" means not significantly different (Mann-Whitney U-test).

When sites from all regions were combined, metrics were significantly associated with measures of human disturbance made at the reach scale, 10 km upstream, and at the catchment scale (Table 5-2). Of the site scale measures, metrics were most frequently associated with percent fines and the derived variable, PC1-HAB. At a larger scale, metrics tended to associate more closely with urbanization and agriculture than forested areas. Number of eutrophic species and percent very motile were significantly correlated with the greatest number of measures of human disturbance.

Table 5-2. Diatom metrics correlated with measures of disturbance.
Diatom metrics were correlated (Speaman's *r*) with measures of disturbance made at the reach (temperature, conductivity, percent fines and PC1-HAB), 10 km upstream (number of human activities), and the catchment (percent urban, agriculture and forested land cover) for 49 river sites. (* $P < 0.05$; ** $P < 0.01$.)

Metric	Temp	Cond	pH	%Fines	PC1-Hab	Num_Act	% Urb	% Ag	% For
% Sensitive				-0.35 *	-0.44 **	-0.40 **			
% V. Tolerant	0.43 **			0.39 **	0.49 **				
Eutrophic species		0.41 **	0.38 **	0.33 *	0.38 **	0.33 *	0.29 *	0.56 **	-0.39 **
% N heterotrophs				0.40 **	0.40 **	0.37 **	0.38 **	0.35 *	
% Polysaprobic	0.40 **			0.38 **	0.51 **		0.31 *		
Alkaliphilic species		0.29 *	0.43 **					0.51 **	-0.37 **
% High oxygen			-0.31 *		-0.32 *	-0.28 *		-0.40 **	
% V. motile			0.29 *	0.33 *	0.34 *	0.35 **	0.34 *	0.57 **	-0.29 *
RDI		-0.38 **		-0.39 **	-0.50 **	-0.38 **	-0.38 **	-0.40 **	

Metric Selection for the RDI

Of the 12 metrics, three pairs were redundant. Most of the species that were tolerant of low oxygen were also polysaprobic. We chose the polysaprobic metric because it was significantly associated with disturbance in more regions. Two other pairs of metrics, percent tolerant and percent very tolerant, and percent motile and percent very motile were redundant conceptually. For these metrics, the more specific version was chosen. Some of the remaining metrics were significantly correlated with each other but were retained for the index because they were each derived from a different set of species.

Although metrics based on identification to genus may be easier to calculate (Hill et al. in press, Chessman et al. 1999), we selected species level versions of the metrics where possible because they tended to have more significant associations with disturbance. For some attributes, genus level assignments could not be made because too few species within large genera defined the attribute (e.g., percent very tolerant and high oxygen individuals). Only percent very motile was calculated at the genus level.

We selected nine metrics for RDI representing biological information related to tolerance and intolerance, autecological guild, morphological guild, and individual condition. No metrics related to community structure were selected because they were only associated with disturbance related to mining in the NM region.

Index performance

A reliable multimetric index should be influenced more by site differences than by sampling location or time of sampling at the site. We used components of variance analysis to compare the relative influence of site differences, time of sampling, and location of sampling on the variability of the RDI (Figure 5-4). Site differences contributed by far the largest component (73 percent) to the overall variability of the RDI indicating that the RDI was sensitive to differences in site conditions that it was designed to measure. Variability associated with sampling location within the reach was very small (1 percent of the total variance). Variability associated with specific months (i.e., September versus October) was also very small (1 percent); however, variability associated with the interaction of month with site was relatively large (25 percent). The small relative variance associated with specific months means that there was no systematic change in the RDI associated with season; in other words, the RDI was not consistently higher in October. The larger interaction effect means that sites varied in different ways across the sampling season; specifically, the RDI improved for later samples collected at sites with large agricultural areas in their upstream catchments (five out of eight sites). For same-day samples, the RDI differed by one point on average, or three percent of its potential range from 9 to 45.

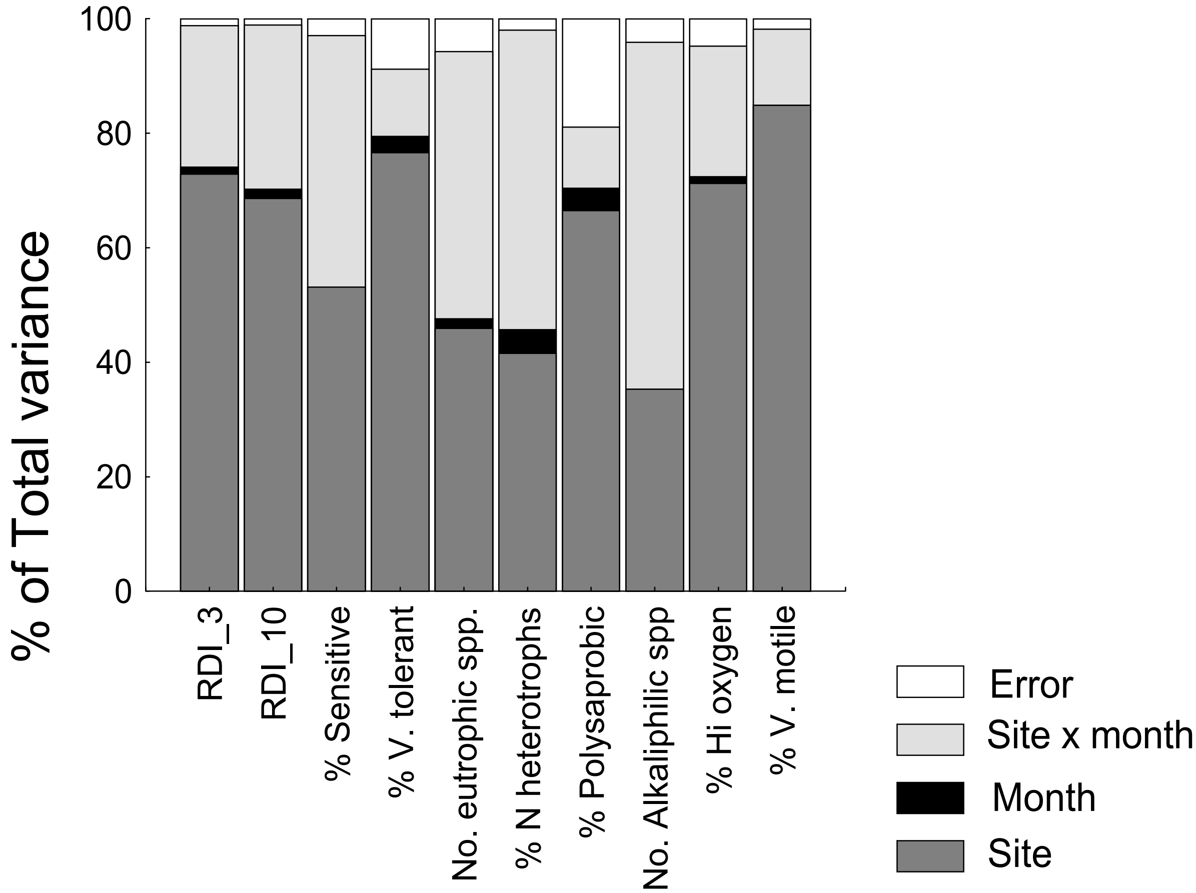

Figure 5-4. Components of variance for two versions of the river diatom index. Based on three (RDI_3) or ten (RDI_10) scoring categories and nine component metrics. Variability associated with site differences, e.g., human disturbance, was highest for RDI and five of the metrics. Samples taken during different months varied more by site (interaction of site and month) than according to time of year (month). Measurement error associated with samples taken on the same day was very low for all measures.

At one site, a thick algal mat was observed only on the second sampling occasion, yet the RDI score changed by only two points. Another site was influenced by a high flow event (dam release) between sampling occasions, but the RDI score differed again by only two points. These observations provide anecdotal evidence that the RDI score was not much affected by unusual events of short duration.

For the component metrics, site differences and the interaction of site and month contributed much more to the overall variability than did transect location or specific month. Compared to its component metrics, the RDI was more precise. This is typical of multimetric indexes because they function mathematically like averages (Fore et al. 1994).

Measurement error was very similar for the two versions of RDI based on three and 10 scoring categories. For the sake of simplicity, we selected the more traditional version (Karr, 1981) based on three categories (Table 5-3).

Table 5-3. Biological metrics for the river diatom index, RDI, response to human disturbance and scoring criteria used to re-scale metric values.

Metric	Response	Scoring criteria 1	3	5
Tolerance and intolerance				
% Sensitive	Decrease	< 60	(60, 80)	> 80
% Very tolerant	Increase	> 15	(3, 15)	< 3
Autecological guild				
Eutrophic species richness	Increase	> 20	(12, 20)	< 12
% Nitrogen heterotrophs	Increase	> 20	(7, 20)	< 7
% Polysaprobic	Increase	> 10	(5, 10)	< 5
Alkaliphilic species richness	Increase	> 30	(18, 30)	< 18
% High oxygen	Decrease	< 25	(25, 55)	> 55
Morphometric guild				
% Very motile	Increase	> 25	(7, 25)	< 7
Individual condition				
% Deformed cells	Increase	> 1	(0, 1)	0

We calculated the number of distinct categories of biological condition that the RDI could reliably detect for three different sampling scenarios. Each scenario used 16 values for the RDI (eight sites x two repeat visits); but in each case, repeat visits were defined differently. For the first scenario, we used same-day samples to estimate mean squared error. For the second scenario, we averaged the RDI scores from September same-day samples to obtain a single RDI value for September and used October samples as repeat visits. The third scenario used one RDI value from the previous year and averaged the three values from 1999.

Results

RDI could reliably detect 11.9 categories of biological condition when repeat samples collected on the same day were used as replicates (Table 5-4). When monthly repeat visits were used as replicates (with same-day samples averaged), RDI was much less precise and could detect 2.5 categories of biological condition (Figure 5-5). When annual repeat visits were used as replicates (with same-year samples averaged), the results were similar and RDI could detect 2.7 categories. Based on these results we defined the following three categories of biological condition for diatom assemblages:

<22 Poor
22-34 Moderate
34-45 Good

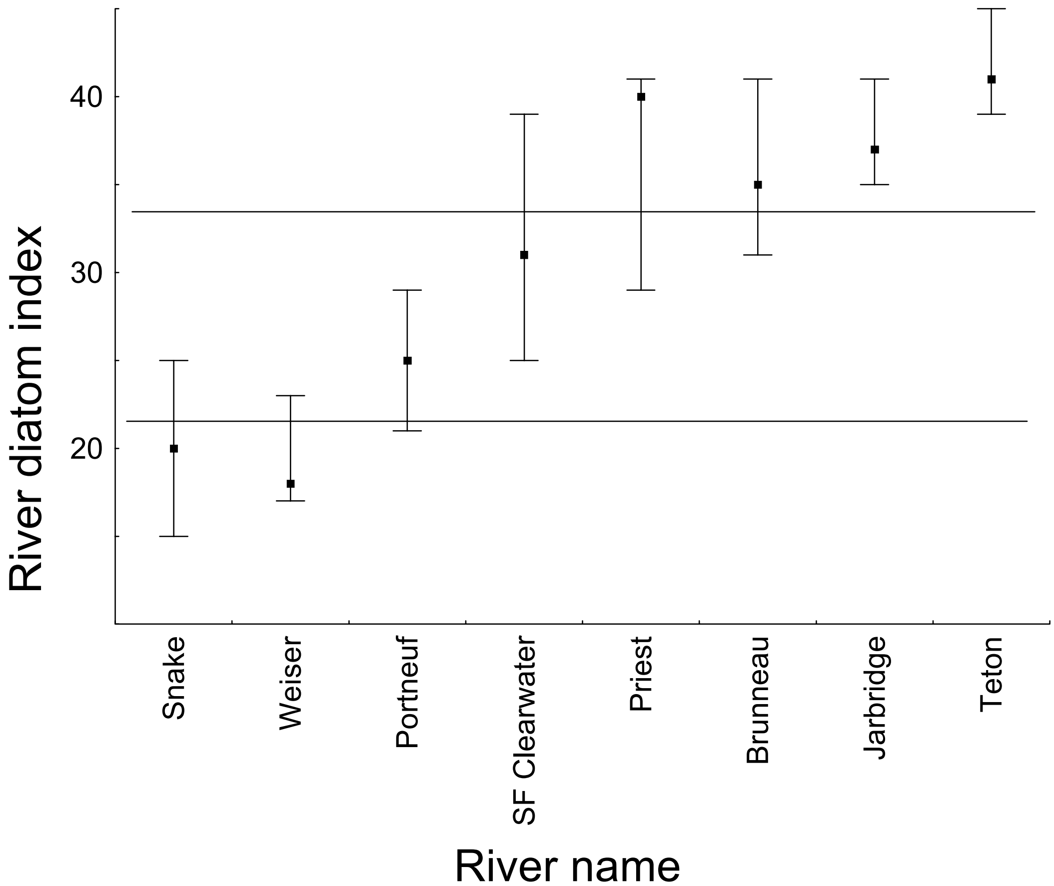

Figure 5-5. Range of values for RDI for eight sites sampled three times in 1999 and once in a previous year.
Horizontal lines indicate categories of biological condition (good, fair and poor) that RDI can reliably detect for comparisons across years. (For comparisons within years, see text.)

Table 5-4. Measurement error of RDI.
This was calculated for three types of repeat visits collected on the same day, during different months and during different years. Index variability was summarized as mean squared error from Anova, percent error relative to variability associated with site differences, and in terms of the number of distinct categories the RDI could detect. For all comparisons, n = 16.

Type of repeat samples	Mean squared error	Percent error	Categories
Same day	1.0	1.0	11.9
Different months	22.8	29.2	2.5
Different years	19.2	22.3	2.7

The RDI was only significantly correlated with measures of natural variability if the measure was also correlated with human disturbance (Table 5-5). The RDI was not correlated with latitude, elevation, channel width, temperature, or pH. The RDI was significantly correlated with stream order, channel slope, and channel depth; but these measures were also significantly correlated with the number of human activities, and in most cases, with each other.

Table 5-5. Correlation of RDI and number of human activities.
Correlation (Spearman's *r*) of RDI and number of human activities with geographic features (latitude and elevation); channel features (order, channel slope, depth and width); and water chemistry (temperature and pH) for 49 river sites. (* $P < 0.05$; ** $P < 0.01$.)

	Lat.	Elev.	Order	Slope	Depth	Width	Temp.	pH
RDI			-0.53 **	0.44 **	-0.36 **			
No. of activities	-0.28 *		0.34 **	-0.36 **	0.45 **		-0.35 **	

At the catchment scale, the RDI was most closely associated with agricultural land use in the SB region and with forested area in the EM region (Figure 5-6). For the NM region, catchment scale measures of disturbance varied little and could not be used to evaluate the RDI. Instead, we used the disturbance categories used initially to test the metrics and found that the RDI was lower for both moderately- and mining-disturbed sites.

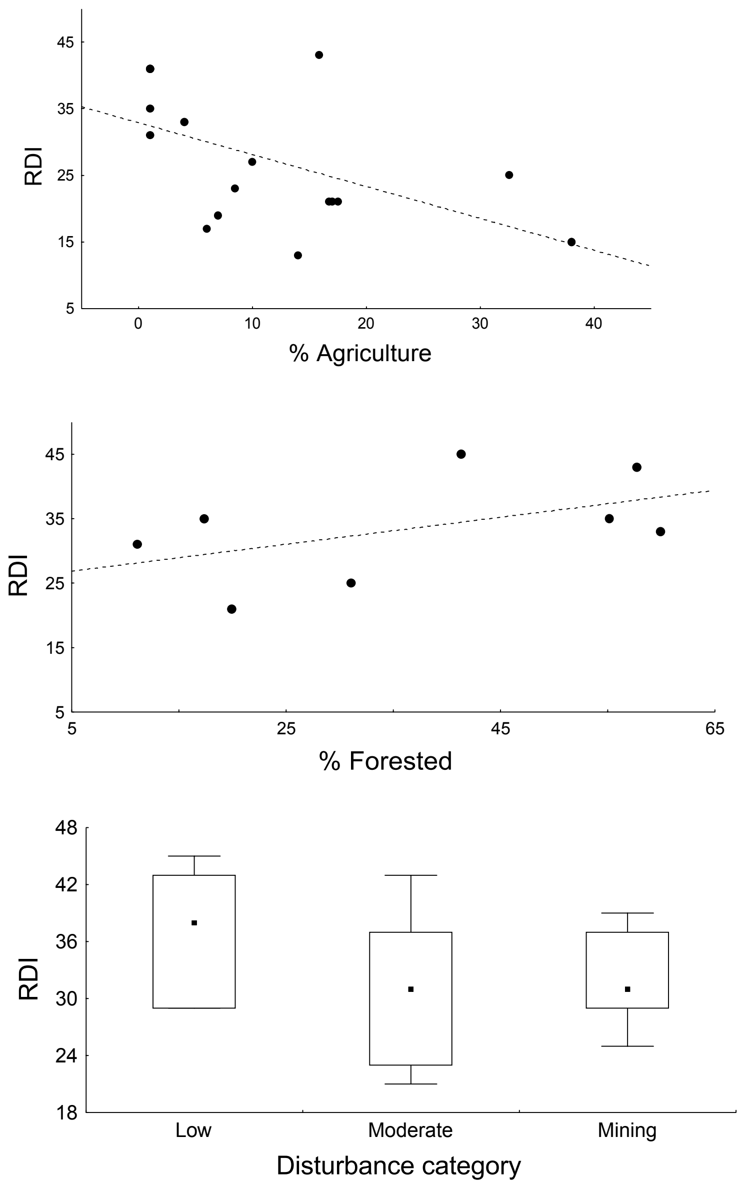

Figure 5-6. Decline and increase of RDI values.
For SB sites, RDI values declined as agricultural area in the catchment increased (upper panel). For EM sites, RDI values increased with forested area (middle panel). Lines are least-squares approximations. For NM sites, RDI was lower for both moderately disturbed and mining disturbed sites.

DISCUSSION

For Idaho rivers, changes in the diatom assemblage were strongly associated with human land use, measured at both the reach and the catchment scale. Diatoms noted as sensitive or tolerant to disturbance in other regions (Lange-Bertalot 1979, Bahls 1993) showed similar responses in Idaho. Several attributes related to autecological guild also shifted at disturbed sites where more eutrophic and alkaliphilic species, more nitrogen heterotrophs, and more polysaprobic valves were found. Shifts in the diatom assemblage related to agriculture (Leland 1995, McCormick and O'Dell 1996, Cuffney et al. 1997, Pan et al. 1999), alkalinity (Chessman et al. 1999) and organic pollution (Kelly, Penny, and Whitton 1995, Rott, Duthie, and Pipp 1998) have been documented by other studies as well. As predicted by others (Bahls 1993, Kutka and Richards 1996), an increase in silt and sediment was reflected by an increase in motile diatoms that can move across the substrate and avoid being buried by shifting sand. Total taxon richness declined at mining sites similar to other studies (Genter and Lehman 2000, Verb and Vis 2000), but was not significantly associated with other disturbances; therefore, we did not include it in the RDI. Inconsistent response to disturbance in other studies has been reviewed by Hill et al. (in press). Our results support the idea that total taxa richness only declines at intense levels of disturbance (Chessman et al. 1999).

The structure of the RDI differs from many other diatom indexes because it includes multiple measures of biological condition based on general tolerance, autecological guild, morphological guild, and individual condition. Other indexes typically summarize the sensitivity of each taxon to a single type of biological change such as eutrophication or saprobity (Prygiel and Costa 1993, Kelly et al. 1995). Multimetric indexes include measures from different levels of biological organization in order to be responsive to many types of disturbance and to be regionally applicable. In contrast, the component metrics can respond independently to different types of disturbance and suites of metrics and may define a "signature" for a particular type of disturbance (Yoder and Rankin 1995). In our study, mining sites had fewer sensitive valves, fewer eutrophic and alkaliphilic species, and more deformed valves than sites with other types of disturbance. Pan and Stevenson (1996) made a similar distinction between wetland sites affected by mining and agriculture. Though not included as metrics, an increase in the number of oligotrophic and oligosaprobic species at mining sites further supports the idea that metals, such as zinc, affect diatoms differently by interfering with the uptake of phosphorus (Kuwabara 1985).

Although polysaprobic and eutrophic diatoms are both influenced by enrichment, different taxa may distinguish between different sources. Our land use information was not sufficient to test this idea; but other studies have used diatoms to distinguish between organic and inorganic effluent (Kelly 1998, Rott et al. 1998). These distinctions are useful when regulating and managing human use.

In a regulatory context, changes in the biological assemblage related to human activities must be clearly distinguished from changes associated with natural variability (Howlin, Hughes, and Kaufmann in press). We used multiple, independent tests in three geographic regions to insure that the selected metrics were robust indicators of the various types of disturbance common in Idaho. Across regions, the same attributes tended to correlate with disturbance, indicating that the selected metrics were not greatly influenced by geographic differences. Pan et al. (2000) also found that human disturbance was more important in structuring diatom assemblages than ecoregional differences. Furthermore, the RDI was not correlated with latitude, elevation, channel width, temperature, or pH. The RDI were, however, significantly lower at higher order sites that were deeper and had lower gradients; but these sites also tended to have more intense disturbance. We conclude for our data that the RDI was only associated with natural features when they in turn influenced patterns of human land use; otherwise, the RDI was not associated with measures of natural variability.

Sampling and Analysis Protocol for Diatoms

A robust monitoring tool should be sensitive to site differences associated with human disturbance but not much affected by small differences in location or time of sampling (Fore et al. 1994, Barbour et al. 1999, Kaufmann et al. 1999). RDI values for same-day samples differed by only three percent indicating that the current sampling protocol yields precise measures of the diatom assemblage and that neither the number of valves nor the area sampled needs to be increased. In addition, replicate same-day samples are not necessary. On the other hand, variability associated with time of sampling was much higher (22 to 29 percent). In comparison, a multimetric index for stream invertebrates showed the opposite pattern, with about 10 percent of the variability in index values associated with different sampling locations within the same reach and zero percent of the variability associated with time of sampling (Fore et al. in press). These differences are probably due to the greater mobility and longer life cycles of invertebrates.

Our sample size was too small (eight sites) to determine whether changes in RDI through time stemmed from natural seasonal shifts in the diatom assemblage or from changes in human activity. Agriculture took place in the upstream catchment of five of the eight sites and RDI increased for all five from September to October. At that time of year, irrigation, fertilization and herbicide application all cease while crops are harvested; thus, diatom assemblages may well reflect real changes in human land use. It would be more accurate to use only reference sites to estimate the influence of seasonality on RDI values, but large river sites with little or no human influence are difficult to find.

Quantifying Human Disturbance

The method used to quantify human disturbance is necessarily specific to the geographic region of interest because physical processes and features determine what types of human activities are possible (e.g., farming in river valleys and timber harvest on mountain slopes) (Omernick and Gallant 1986). The number of human activities was a reasonable measure of human influence in southern Idaho because different types of human activities tended to cluster together. Strong correlation between urban and agricultural land cover supported the idea that much of the economy in southern Idaho is based on agriculture. In northern Idaho, human activities were not as strongly clustered geographically.

For this study, our measures of disturbance were approximate at best. We evaluated the association of diatom metrics with multiple measures of human disturbance because human activities degrade catchments and surface waters in diverse ways: by altering or destroying the natural habit, disrupting energy cycles, modifying flow regimes, releasing chemicals, and propagating alien species (Karr et al. 2000). In the course of relating diatom attributes to human disturbance, we could estimate the measurement error associated with the biological metrics and index; but on the other side of the equation, the error associated with measures of disturbance could not be quantified or mitigated.

At the catchment level, livestock grazing was common and pervasive, but could not be quantified for this study. Livestock grazing can be very damaging to river ecosystems by causing erosion, loss of riparian cover, nutrient enrichment from excrement, and loss of instream habitat (Armour, Duff, Elmore 1994, Fleischner 1994). The influence of disturbance in the catchment area further upstream may also be important but was not considered for these rivers because of their large size. At the reach scale, water chemistry information was not available and we could not assess the relative influence of nitrogen, phosphorus, or heavy metals. Sorting out the relative influence of different human activities (Richards, Johnson, and Host 1996, Roth, Allan, and Erickson 1996) may be more easily accomplished for smaller streams where different activities are isolated within catchments.

Statistical Considerations

Diatom samples used in statistical testing were not necessarily independent because more than one sample site was located on some rivers. Statistical testing assumes independence because correlation and significance can be inflated when values are similar due to physical proximity rather than the independent factors being tested (Hurlbert 1984, Dunham and Vinyard 1997). The average range in RDI values for different sites on the same river system was 11 (out of a possible 36) points, indicating that sites located on the same river could have quite different RDI values; in one case, two sites differed by 32 points. This does not prove independence, but supports the idea that biological condition was not constrained by upstream conditions and could vary in response to human activities near the site. We elected to include all the sites in the statistical tests for two reasons. First, sites were at least 2 km apart and often much farther (greater than 50 km). Second, a sufficiently large sample size is difficult to obtain for rivers of this size.

Lack of independence was much more of a concern for mining sites in the NM region because six of the seven sites were located along an approximately 40 km section of the Coeur d'Alene River. We reported the results for three reasons: the data set was adequate to characterize the changes in the diatom assemblage if not provide a specific test, the differences associated with these sites were dramatic and suggest that diatoms may be very robust indicators of metal contamination, and biological endpoints are in great demand for assessing the remediation of abandoned mine sites (Clements et al. 2000).

Diatoms as Indicators

Fish, invertebrates, and diatoms represent different trophic levels and integrate environmental conditions over different temporal and spatial scales. Therefore, we expect them to be affected differently by different types of disturbance (Allen et al. 1999). For example, physical barriers such as dams are probably more disruptive to fish populations than to diatoms. On the other hand, heavy metal concentrations that eliminate many diatoms may be tolerated by fish that can travel further to refugia. For rivers in Idaho, diatoms may represent a biological alternative to fish when sites are too deep to effectively sample fish or when endangered and protected species prohibit sampling entirely. In contrast with longer-lived organisms, the quick response of diatoms to riverine conditions makes them an excellent tool for evaluating and comparing management practices within a year or season. Finally, in cases where chemical and biological information disagree about site condition, diatoms may provide clues for resolving the conflict because of their sensitivity to water chemistry and their nature as living organisms.

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Chapter 6.
RIVER PHYSIOCHEMICAL INDEX

Darren Brandt[10]

INTRODUCTION

Water quality indexes were developed in the 1970s and used through the 1980s to interpret conventional physiochemical water data (EPA-STORET WQI, Peterson 1980; OWQI, Dunnette 2000, 1980 NFS WQI McClelland 1974, DEQ 1989). For instance, DEQ used the WQI (EPA STORET data) for the 1988 and 1992 305(b) reports (DEQ 1989,1992). DEQ discontinued using the WQI when the BURP program was developed. At the time, bioassessment information was considered a better indicator of water quality than limited chemical data. This assumption has worked well for small wadeable streams; however, as the team began to assess large and medium rivers it became apparent that water chemistry data could be very valuable as a supplemental data source to biological data.

Therefore, the large river assessment team investigated various WQIs that might be applicable to Idaho streams. After investigating several different indices, the team decided to use the Oregon Water Quality Index (OWQI) as an interim index until Idaho could develop a WQI that was tailored to Idaho streams. The River Physicochemical Index (RPI) is based on the OWQI[11]. This index has been tested and used extensively in Oregon to assess water quality conditions (Cude 1998).

METHODS AND RESULTS

Oregon Water Quality Index

The OWQI uses eight water quality parameters to determine the condition of a water body (Table 6-1). The sub-index scores for each of the variables are calculated using complex regressions for data that falls within a set range for each of the variables and threshold scores for data outside of that range. The range of potential values for each sub-index is from 10 to 100. The regression for each of these parameters can be found in Appendix F (Cude 1998).

[10] Idaho Department of Environmental Quality, 2110 Ironwood Parkway, Coeur d'Alene, ID 83814.
[11] Since the working definition of "water quality" has been expanded through the 1990s to include biological conditions, the term "River Physiochemical Index" (RPI) more accurately describes this index and is used in favor of the original term "water quality index."

Table 6-1. Water quality parameters used in the OWQI

Temperature	Total solids
Dissolved oxygen	Ammonia + nitrate nitrogen
Biochemical oxygen demand	Total phosphorus
pH	Fecal coliform

The individual sub-indexes are then averaged to give a single index value. There are several methods of calculating central tendency. The most common methods are used to determine the arithmetic mean and the geometric mean. The geometric mean is usually used where there is a large amount of between-sample variability. The geometric mean will always return a mean score lower than the arithmetic mean. For samples with even greater variability or where it is important for rare but important low values to have more weight, one can calculate either the harmonic mean or the harmonic square mean. Of these two methods, the harmonic square mean is the most sensitve to low values in the data set. The OWQI uses the harmonic square mean method for determining central tendency. The harmonic square mean is similar to the calculation of a harmonic mean except that a step is added in the calulation process that squares individual values before summing them. The product is then back transformed to derive the harmonic square mean. The equations for the harmonic mean and the harmonic square mean are as follows.

$$Harmonic\ Mean = \frac{n}{\sum_{i=1}^{n} \frac{1}{SI}} \qquad Harmonic\ Square\ Mean = \sqrt{\frac{n}{\sum_{i=1}^{n} \frac{1}{SI_i^2}}}$$

Where SI is the individual sub-index scores.

Both the harmonic mean and harmonic square mean methods are designed to give a greater response to changes in a single variable than other methods of calculating means. The OWQI uses the harmonic square mean rather than other measures of central tendency to insure that a single poor sub-index score carries more weight in the calculation than high scores. This insures that final scores are weighted in favor of environmental protection. An illustration of the effect of using different procedures for calculating central tendency can be seen in Table 6-2. As you can see, the harmonic square mean is much more conservative and responsive to a single low value than any of the other methods considered.

Table 6-2. Procedures for calculating central tendency.
The mean of the following data series using four different methods to calculate central tendency (10, 90, 90, 90, 90, 90, 90, 90).

Arithmetic Mean	Geometric Mean	Harmonic Mean	Harmonic Square Mean
80	68	45	27

Index Testing on Idaho Rivers

Prior to using the OWQI, we determined that it was necessary to test the index on Idaho rivers. The OWQI as described by Cude (1998) uses several different sub-index curves for total solids. DEQ decided to test the OWQI using a common total solids equation without regard to location within the state. Additional testing may be conducted to derive total solid equations for different regions within Idaho; however, due to time and data constraints we felt that for testing purposes a single total solids equation was appropriate. The revised OWQI will be called the RPI to ensure that the reader is aware that the testing was not done using the OWQI as written. DEQ used the total solids equation developed for the John Day, Umatilla, and Grande Ronde Basins and the Crooked subbasin in Oregon.

The data set used to test the RPI was from USGS trend monitoring stations. To determine the overall condition of a water body from several sampling runs, we calculated the harmonic mean of individual RPI scores from all dates. Once again this was done to insure that sampling runs with the worst water quality conditions would be weighed more heavily. Since the USGS trend monitoring stations were not established with the RPI in mind, not all of the parameters were collected. Biochemical Oxygen Demand (BOD) was not collected at any time; and therefore all testing will be based on a composite RPI score from seven not eight parameters. Occasionally, an additional parameter was not collected or the sample was discarded. For these individual runs, it was determined that a minimum of six of the eight parameters must be reported prior to calculating a RPI score.

The average RPI scores by station calculated using the harmonic mean function can be found in Appendix G.

<u>RPI versus RMI and RFI</u>

Other chapters in this document discuss using diatoms and macroinvertebrates to determine water quality conditions in large rivers. Prior to inclusion of the RPI into the large river assessment process we wanted to test how it responded relative to the other indexes proposed. Unfortunately, only five sites had data sufficient for RPI calculations and biological data in the form of diatoms and macroinvertebrates. Because of the low paired sample sites, the result of the testing will not be as powerful as we would like; however, the results thus far are very encouraging.

A simple regression analysis was done on the five paired sites to determine if the RPI scores responded to environmental stressors in a similar fashion as the RFI and RDI. A significant linear regression exists between the RDI and the RPI (Figure 6-1). The R^2 for this regression was 0.85 and this was significant at the 0.05 level. The regression was also positive indicating that the RPI and the RMI responded in a similar manner. The regression analysis done between the RPI and the RMI was not significant at the 0.05 level; however, this is most likely due to small sample size (Figure 6-2). The RPI and RFI appear to respond in a similar manner even though there is not a significant regression. DEQ will continue to collect water chemistry data necessary to calculate the RPI and macroinvertebrates at the same locations. We expect that as the data set increases we will find that the RPI is correlated to the RFI.

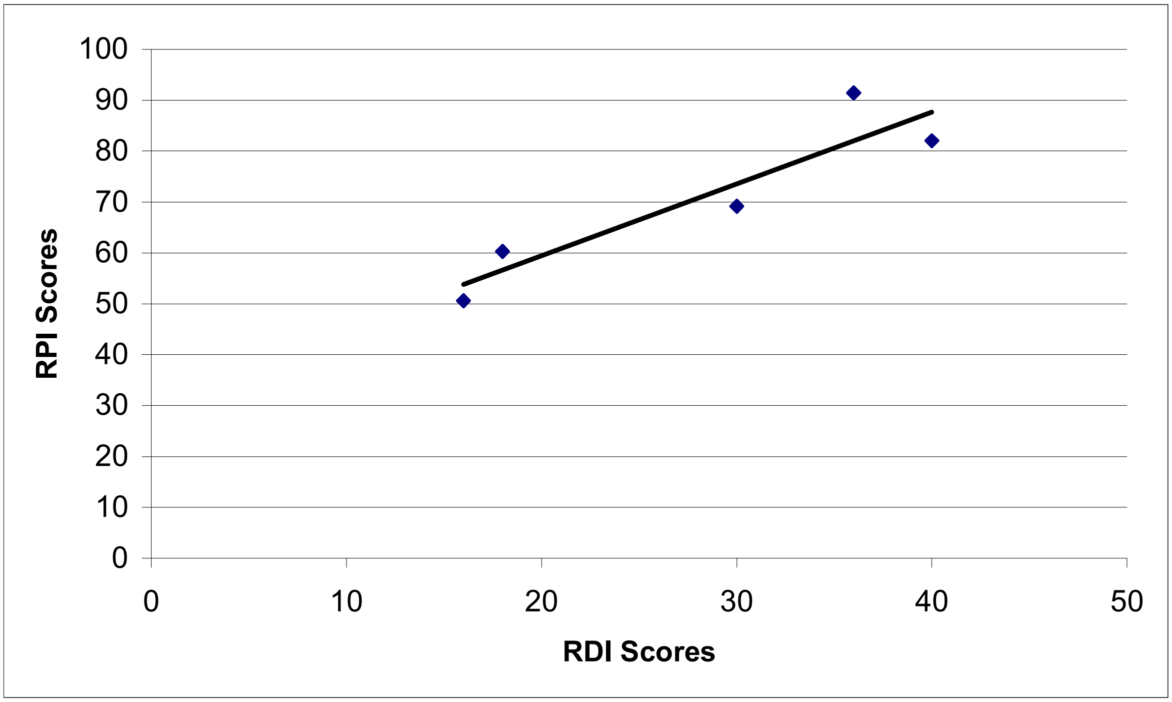

Figure 6-1. RPI scores versus Idaho's RDI. (R^2=0.85 p<0.05)

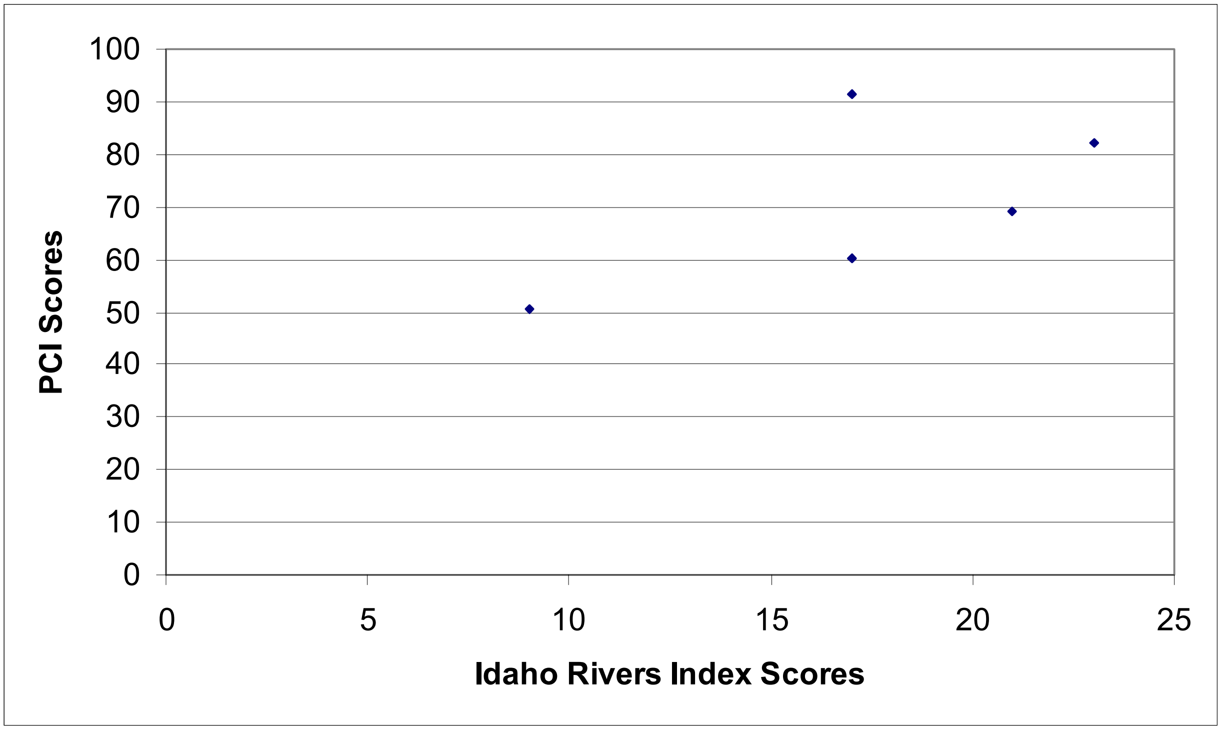

Figure 6-2. RPI scores versus Idaho's RMI.

RPI versus Indications of Human Disturbance

Land use percentages of the 5th field HUC in which the station was used as a surrogate for human disturbance. Land uses within the 5th field HUCs included: percent forest, percent dryland agriculture, percent gravity-irrigated agriculture, percent sprinkler-irrigated agriculture, percent rangeland, percent urban, and percent riparian. The percentage of each land use within each 5th field HUC was determined through the use of GIS and the Idaho Department of Water Resources Land use coverage and hydrologic delination.

The first analysis performed was a simple regression analysis of RPI versus all of the individual land use types. For this analysis the three categories of agricultural land use were combined into one land use category called total agriculture.

For the watersheds that had percent forest as a land use there was a significant positive regression with percent forest and RPI scores (Figure 6-3).

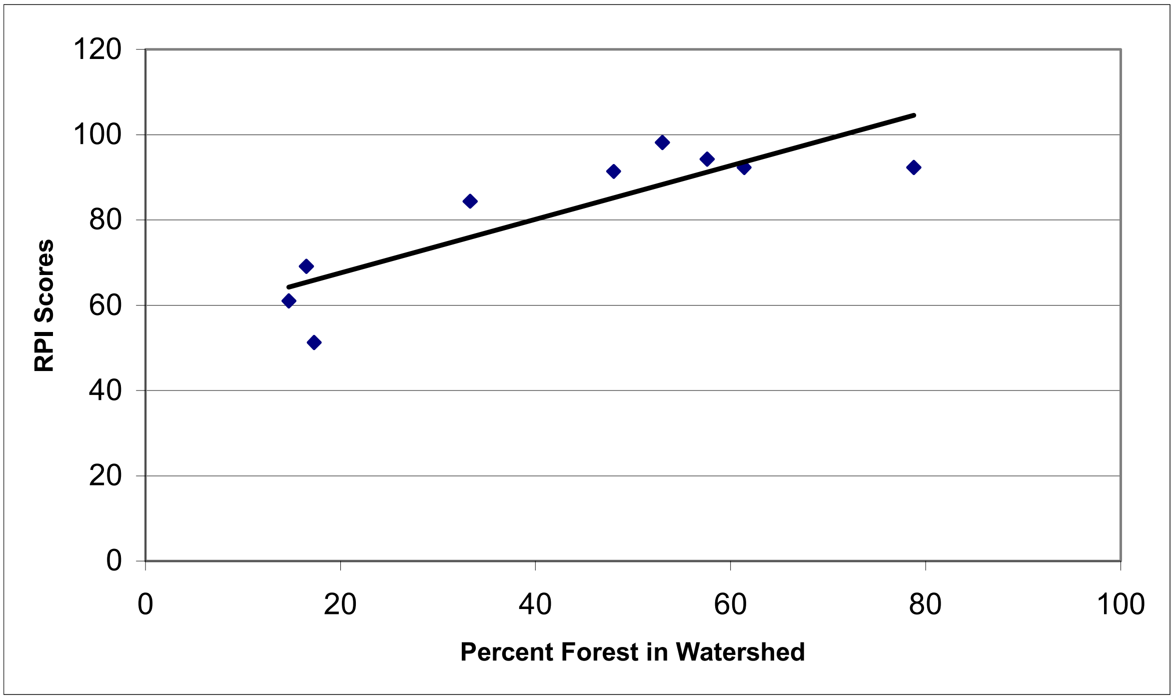

Figure 6-3. RPI Scores versus percent forest in 5th field watersheds where forest lands were a described land use. (R^2=0.75 $p<0.05$)

Another significant regression was a negative regression between RPI scores and percent agriculture in the watershed (Figure 6-4). Although the R^2 is not as high as the regression with percent forest, it is still highly significant.

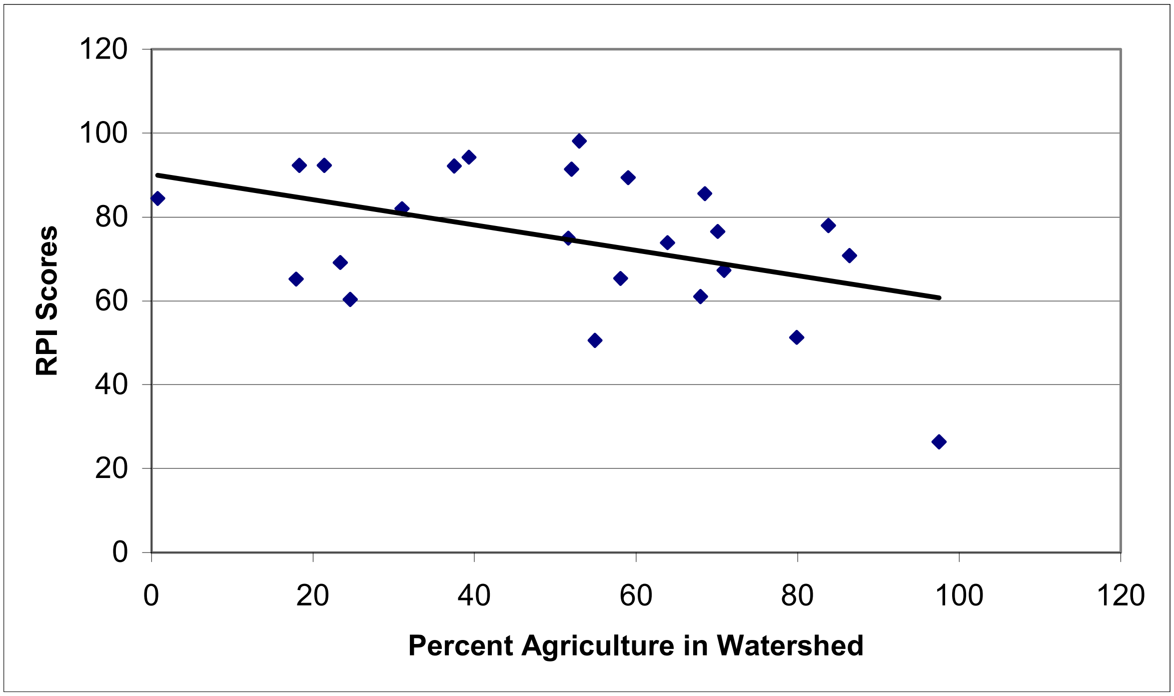

Figure 6-4. RPI Scores versus percent agriculture in 5th field watersheds where agriculture was a described landuse. (R^2=0.22, $p<0.05$)

Also of significance is the slope of the regressions. Both of the regressions respond in ways one would expect. As percent forest increases, so does the RPI score and as percent agriculture increases, the RPI score goes down. We also ran a forward step-wise regression which indicated that percent forest, percent dryland agriculture, and percent-furrow irrigated agriculture predicted approximately 50percent of the variablility in RPI scores (R^2=0.499 $p<0.05$). These characteristices would seem to indicate that the RPI does respond to changes in land use and could be a useful tool to predict water quality support status.

RPI versus Professional Expectations

We also wanted to determine if the RPI agreed with water quality professionals' opinions in regards to the rivers status. We asked DEQ employees who have experience in collecting and assessing water quality data to rate selected rivers on a scale of 1 to 3. They were asked to score rivers that were impaired as a 1. Rivers that were in good condition were to receive a 3 and rivers that had some degree of degradation were to receive a score of 2. The RPI scores were plotted against the expectations of DEQ employees for a visual examination of the data (Figure 6-5). Streams that were scored as either a 1 or 2 had a fair amount variability; however, streams that were determined to be in good condition had little variability. This trend is fairly common in this type of testing. People are very confident that streams or rivers that are in good condition, but the confidence and differences in expectations results in increasing variability as water bodies become more degraded. The results are encouraging because of the complete lack of overlap of RPI scores for rivers people considered in good condition and scores of rivers people considered degraded. The results from this analysis also tends to support the use of the RPI for determining the status of large rivers.

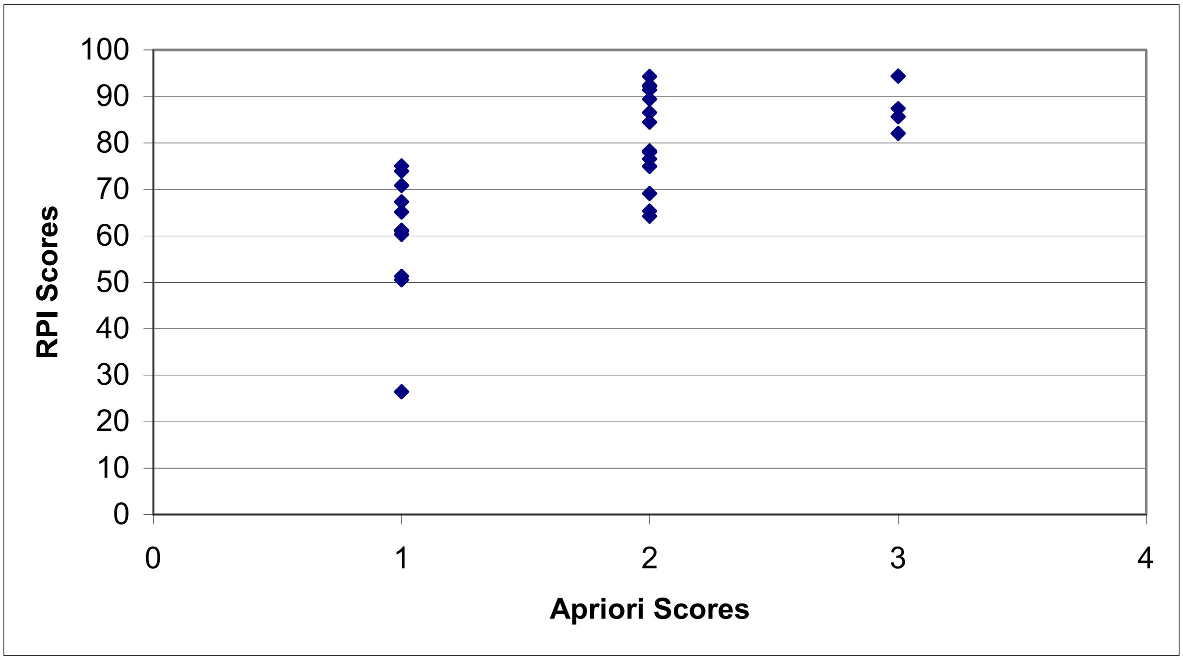

Figure 6-5. RPI Scores versus Apriori Scores.

This analysis was also used to help determine the four condition categories that will be used in the assessment process. It was apparent that water bodies with scores in excess of 80 were considered to be in good condition. It was also apperent that streams with scores less than 70 were significantly different from what would be expected of the them if they were in pristine condition. Therefore, it was determined that DEQ would use the following classifications for determining river condition using the RPI (Table 6-3).

Table 6-3. Proposed categories for the RPI.

Threshold Value	Signficant Deviation from Expected Condition	Moderate Deviation from Expected Condition	Similar to Expected Condition
<40	40-70	70-80	>80

Based on the analysis described above, DEQ believes that the RPI can be a valuable tool in determinating support status for large rivers. Eventhough the data sets were limited and the RPI needs additional testing, all tests performed on the RPI support its ability to descriminate between rivers that are in good condition and rivers that are degraded.

Sampling Requirements

In an effort to make sure that condition statements are made with as much rigor as possible, we set out to determine the minimum number of samples necessary for DEQ to use the RPI with reasonable assurity that differences in RPI scores of 10 points were statistically different. Therefore we ran a power analysis to determine the minimum number of samples needed to evaluate water quality conditions. We determined that a reasonable goal was to determine the number of samples necessary to assure that a 10 point difference in a score was significant to the 0.10 level 80 percent of the time. The average standard deviation from our test data set was nine points. The power analysis results indicated that a total of 10 data points were needed to determine if a 10 point difference was significant 80 percent of the time. A minimum of four samples would be needed if we only wanted to determine a 15 point difference 80 percent of the time. Any status calls made using less than 10 samples should be made with caution due to the increased possibility of making an incorrect status call. The data can and should still be used; however, it may be prudent for the assessor to be more cautious of the resulting scores.

CONCLUSIONS

The RPI is consistent with the RDI and the RFI. The RPI appears to correlate with measures of human disturbance, particularly agriculture and forest percentages within a watershed. The RPI also corresponds with professional opinion regarding the status of river conditions.

The test data set used had a large percentage of sites from southern Idaho. Future testing should be done to confirm that the index works for the entire state. Although there were relatively few sites from northern Idaho the assumptions made in the RPI should hold true for northern Idaho as well as southern Idaho and the preliminary analysis does not indicate that northern Idaho rivers respond any differently than southern Idaho rivers in regards to the RPI. Therefore, the RPI should be used as an interpretive tool with the caveat that future testing will need to be done to confirm the reliability of the index for northern Idaho. Users should not try to apply the RPI for rivers known to be impaired by toxics such as pesticides or heavy metals. These pollutants were not intended to be assessed using the RPI and the results of the RPI would not be indicative of the status of rivers impacted by these other pollutants. Given the results of these analysis, the RPI can be a valuable interpretive tool in assessing large river conditions in Idaho.

ACKNOWLEDGEMENT

I would like to thank Curtis Cude for his valuable insight, Mike Ingham for his review and assistance and all the DEQ personnel that provided data for testing the RPI.

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Chapter 7.
DATA ASSESSMENT AND REPORTING OF ASSEMBLAGES

Cynthia S. Grafe[12], Darren Brandt[13], and Christopher A. Mebane[14]

INTRODUCTION

To be meaningful to managers and the public, biological and physical habitat data need to be translated into logical information that communicates the assessment results. The challenge is how to interpret and report all the results from different indexes, particularly when the results disagree.

Both numeric criteria evaluations and multimetric index results are used to evaluate cold water biota in rivers. For the RMI, RFI, and RDI, DEQ rates different categories of conditions and then averages these ratings into one score. DEQ uses minimum index thresholds that identify significant impairment signals that may be lost through averaging scores. This approach is applied according to available data during the assessment process. If there are not enough data types to calculate two different indexes, then the water body is not assessed until more data are gathered. Figure 7-1 illustrates the process of applying this approach.

METHODS

River Index Scoring

DEQ uses BURP-compatible data to calculate the River Macroinvertebrate Index (RMI), River Fish Index (RFI), and River Diatom Index (RDI). The results from these indexes are used to evaluate support use of cold water aquatic life in rivers. DEQ may also use physicochemical data to identify numeric criteria violations of water quality standards (see Section 5 Grafe et al. 2002) and/or other available data to support or modify assessment interpretations (see Section 4 Grafe et al. 2002).

The RMI, RFI, and RDI are direct biological measures of cold water aquatic life. The details of index development and supporting analyses may be found in Royer and Mebane (Chapter 3), Mebane (Chapter 4), Fore and Grafe (Chapter 5), and Brandt (Chapter 6).

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[13] Idaho Department of Environmental Quality, 2110 Ironwood Parkway, Coeur d'Alene, ID 83814.
[14] Idaho Department of Environmental Quality, 1410 N. Hilton, Boise, ID 83706.

Scoring methods used for the river biological indexes differ according to the techniques used to develop the indexes. The RMI and RFI used reference condition approaches similar to those methods used in the development of the SMI and SFI. The developers of the RMI and RDI did not adjust index scores to a 100-point scale. Therefore, the maximum scores of these indexes are the highest scores of the individual metrics comprising the indexes. However, the RFI is based on a 100-point scale.

Both the RMI and RFI base condition categories on the 25th percentile of reference condition, which is considered adequately conservative in identifying sites in good condition (Jessup and Gerritsen 2000). DEQ applies the authors' recommendations when identifying additional condition categories. For the RFI, DEQ uses the median and 5th percentiles; below the 5th percentile is distinguished as a minimum. For the RMI, Royer and Minshall (1996) recommended the minimum score of the reference condition to distinguish additional condition categories. DEQ evaluated the range in each condition category of the RMI and then linearly extended the range to identify a minimum threshold.

The development of the RDI scores were based upon the distribution of the entire data set rather than just reference sites, due to the limited number of reference sites. Fore and Grafe recommend scores assigned to the different index categories based on the 75th, 50th, and 25th percentiles. Fore and Grafe did not have supporting analysis to recommend a minimum threshold.

Although the RPI is not used in the river data integration process, the index results may still be used in water quality interpretations and decisions other than 303(d). The RPI uses a scoring classification approach based on the development methods of the Oregon Water Quality Index (Cude, 2001), the index on which the RPI is based. Standard deviation was used to identify the different index categories of expected condition.

Each condition category is assigned a rating of 1, 2, or 3 to allow effective integration of multiple index results into one score. The final score derived from these multiple data sets is then used to determine use support. Table 6-4 summarizes the scoring and rating categories for the RMI, RDI, RFI, and RPI. It should be noted that the RPI scoring criteria is provided for information purposes only. This index is not directly used in the river data integration process. However, the RPI results may be used to supplement water quality interpretations.

Table 7-1. RMI, RDI, RFI, and RPI Scoring and Rating Categories

Index	Minimum Threshold	1	2	3
RMI	<11	11 – 13	14 – 16	>16
RDI	NA[1]	<22	22 – 33	>34
RFI	<54	54-69	70-75	>75
RPI	<40	40 – 70	70 – 80	>80

[1]Fore and Grafe (2000) did not identify a minimum threshold category.

Index Data Integration Approach and Use Support Determination for Rivers and Streams

DEQ believes that water bodies require an integration of multiple data types to assess ecosystem health. With this in mind, DEQ does not use any one piece of evidence to solely assess aquatic life use support. The multiple data integration approach is applied according to available data during the assessment process. If there are not enough data types to calculate two different indexes, then the water body is not assessed until more data are gathered or other Tier I data can be used according to policies described in the Water Body Assessment Guidance, Second Edition (Grafe et al. 2002). Figure 7-1 illustrates the process of applying this approach.

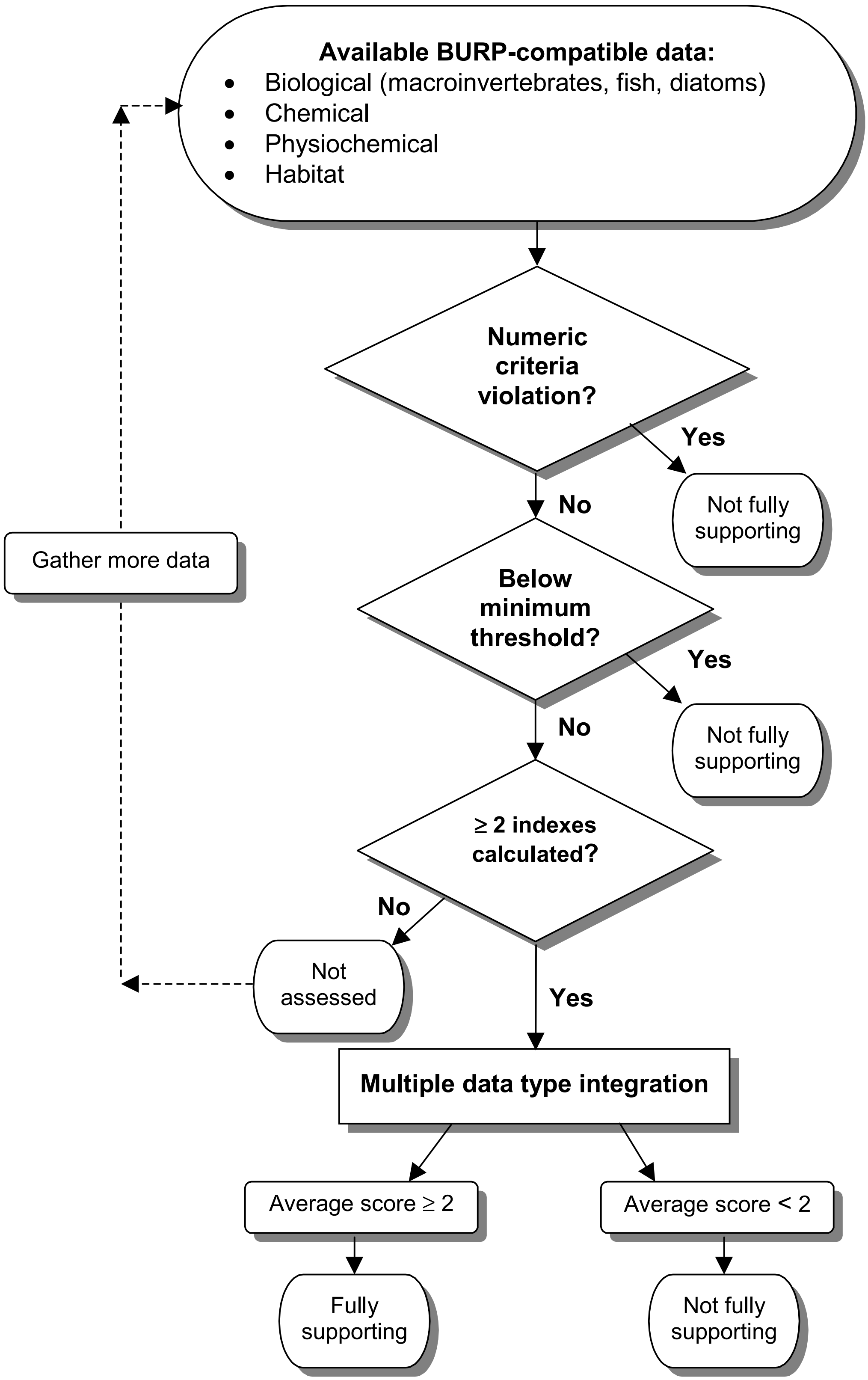

Figure 7-1. River cold water aquatic life use support determination.

The index integration approach uses the following steps to determine use support of cold water aquatic life for streams and rivers.

Step 1
Identify any numerical water quality standard violation as determined by using the criterion evaluation and exceedance policy (see Grafe et al. 2002).

If there is a numeric criteria violation, then DEQ automatically determines the water body is not fully supporting.

Step 2
Calculate the index scores and determine if there are at least two indexes.

If there are less than two indexes, then the water body is not assessed unless other Tier I data is available (Grafe et al. 2002). Additional data should be gathered.

Step 3
Identify any index scores below the minimum threshold levels.

If there are any scores below minimum threshold levels, then DEQ automatically determines the water body is not fully supporting.

Step 4
Identify corresponding 1, 2, or 3 condition ratings for each index.

Step 5
Average the index ratings to determine the use support. To average the individual index ratings, sum the ratings and divide by the number of indexes used.

An average score of greater than or equal to 2 is considered fully supporting.
An average score of less than 2 is considered not fully supporting.

Step 6
Review these preliminary, quantitative results to ensure that they meet logical expectations and data requirements. If not, re-evaluate the data and provide sound justification for support status ratings/assignments different from the indication of the quantitative results (see Grafe et al. 2002).

Examples of the River Ecological Assessment Approach[15]

Lower Payette River

The lower Payette River is located in the southwestern portion of Idaho (Figure 7-2). The river flows westerly to join the Snake River near Payette, Idaho. The sampling location is in Payette, Idaho downstream from the wastewater treatment plant. Sources of pollutants include both point sources and non-point sources. Agriculture is the dominant land use with approximately 100,000 acres under some form of irrigation. Uplands are mainly used for open grazing of cattle and sheep. Other non-point sources are associated with urban land use. Point sources are limited mainly to municipal treatment plants and confined animal feeding operations.

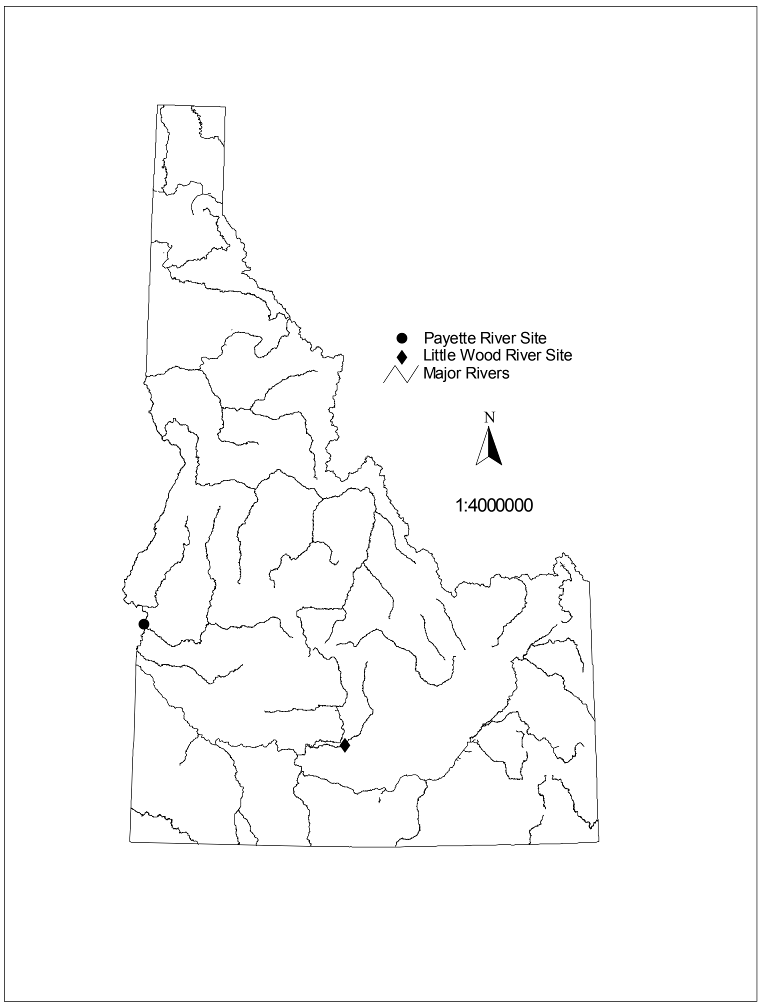

Figure 7-2. Sample locations of example rivers.

[15] These examples are intended to illustrate the index integration approach only and are not intended as a DEQ finding of beneficial use support status for the listed examples.

Little Wood River

The Little Wood River originates in the Pioneer Mountains in south central Idaho (Figure 7-2). From its headwaters, the river flows through forested areas and then enters into the Little Wood Reservoir, an irrigation supply reservoir. After leaving the Little Wood Reservoir, the Little Wood River flows through sagebrush steppe where it is used heavily for irrigation water as it approaches the town of Richfield. The Little Wood River joins the Big Wood River just west of the town of Gooding. The sampling location on the Little Wood River is near Carey, Idaho. This sampling location is upstream of the most heavily used sections of the Little Wood River.

ALUS Quantitative Assessment

- **Collect existing and readily available data.** In these examples, IDFG data was available to calculate the RFI scores for both sites. Also, DEQ collected macroinvertebrate and periphyton data at both sites. USGS data was collected at the lower Payette River site.

- **Identify numeric criteria exceedances.** For purposes of this example to illustrate the multiple data integration approach, it is assumed there are no numeric criteria exceedances. If there were any exceedances, then the determination would be not fully supporting.

- **Calculate indexes.** Table 7-2 shows the index results. The RPI is not used in the index integration, but may be used as additional information.

Table 7-2. River index score results (preliminary).

Site	RMI[16]	RDI	RFI
Payette (near wastewater treatment plant)	15	8	14
Little Wood River near Carey, Idaho	21	38	82

- **Classify index scores.** The assessor assigns a 1, 2, or 3 score to each index. Table 7-3 shows the assignment of scores according to the information provided in Table 7-1.

Table 7-3. River condition rating assignments.

Site	RMI	RDI	RFI
Payette (near wastewater treatment plant)	2	1	Below Minimum Threshold
Little Wood River near Carey, Idaho	3	3	3

- **Identify threshold exceedances**. As seen in Table 7-3, the assessor identifies that the RFI is below the minimum threshold for the Payette River site and consequently, determines this site as not fully supporting. The Little Wood River site does not have index scores below any minimum thresholds.

[16] RMI calculations based on 1996 DEQ macroinvertebrate taxa list.

Table 7-4. River ecological assessment results.

Site	Numeric Criteria Exceedance?	Below Minimum Threshold?	Average Index Score	ALUS Determination
Payette (near wastewater treatment plant)	No	Yes	1.5	Not Fully Supporting. RFI score below minimum threshold and average index score less than 2.
Little Wood River near Carey, Idaho	No	No	3	Fully Supporting. Average index score greater than 2.

- **Determine support status.** As seen in Table 7-4, the support status for the segment of the Payette River sampled is not fully supporting cold water aquatic life for two reasons. First, there is a violation of the minimum threshold for the RFI and second, the average index score is <2. The Little Wood River site is determined fully supporting cold water aquatic life since there were no numeric criteria exceedances, no index scores below minimum thresholds, and the average index score was greater than 2.

The assessor would review these preliminary, quantitative results to ensure that they met logical expectations and data requirements. If not, the assessor would re-evaluate the data and provide sound justification to change the preliminary support status. In the above examples, the support status determination seems reasonable due to the level of human disturbance in the watershed and the summary descriptions provided earlier.

The benefits of this integrative approach is that one composite index score indicates aquatic life use status. However, if an individual assemblage's index score is extremely low, then the use of minimum thresholds result in a conclusion that aquatic life is not fully supported. Also, the calculation of the individual and overall scores can be easily performed using spreadsheet or database calculations.

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Appendix A.
1997-98 RIVER BURP SITES

1997 RIVER BURP SITES

Water Body	Date Sampled	HUC[1]	Boundaries	Site I.D.
Boise RO				
Middle Fork Boise River	9-4-97	17050111	Headwaters to Arrowrock Reservoir (site above Roaring River)	1997RSWIROQ001
North Fork Boise River	9-5-97	17050111	Headwaters to MF Boise River (4 miles upstream from Rabbit Creek)	1997RSWIROQ002
South Fork Boise River	9-8-97	17050113	Headwaters to Anderson Ranch Reservoir (site near Pine, Idaho)	1997RSWIROQ003
South Fork Salmon River	9-10-97	17060208	Headwaters to mouth, 0.1 miles upstream from Krassel Gage Site	1997RSWIROQ004
East Fork of South Fork Salmon River	9-10-97	17060208	Sugar Creek to Johnson Creek	1997RSWIROQ005
Total Sites = 5				
Lewiston RO				
South Fork Clearwater River (L)[2]	9-16-97	17060305	Mill Creek to Clearwater River	1997RNCIROQ001
South Fork Clearwater River (M)[3]	9-16-97	17060305	Mill Creek to Clearwater River	1997RNCIROQ002
South Fork Clearwater River (U)[4]	9-17-97	17060305	American River to Mill Creek	1997RNCIROQ003
Lochsa River	9-18-97	17060303	Headwaters to Lowell	1997RNCIROQ004
Total Sites=4				
Coeur d'Alene RO 09/24/97 - 09/30/97				
North Fork Coeur d'Alene River	9-24-97	17010301	Yellowdog Creek to Coeur d'Alene River, SF	1997RNIRO0Q001
Pend Oreille River	9-25-97	17010214	Lake to State Border	1997RNIRO0Q002
Pack River	9-27-97	17010214	Hwy 95 to Lake	1997RNIRO0Q003

Water Body	Date Sampled	HUC[1]	Boundaries	Site I.D.
St. Maries River	9-28-97	17010304	Mashburn to St. Joe River	1997RNIRO0Q004
Coeur d'Alene (Harrison)	9-29-97	17010303	Thompson Lake to Lake Coeur d'Alene	1997RNIRO0Q005
Coeur d'Alene River (Rose Lake)	9-29-97	17010303	Latour Creek to Fourth of July Creek	1997RNIRO0Q006
Coeur d'Alene River (Medimont)	9-30-97	17010303	Robinson Creek to Cave Lake	1997RNIRO0Q007
Total=7				
Idaho Falls RO 10/07/97 -10/09/97				
Falls River	10-7-97	17040203	Conant Creek to Henry's Fork River	1997REIRO0Q001
Teton River (U)	10-8-97	17040204	Trail Creek to Hwy 33	1997REIRO0Q002
Henry's Fork (U)	10-8-97	17040202	Island Park Reservoir to Riverside	1997REIRO0Q003
Henry's Fork (L)	10-9-97	17040202	Riverside to Ashton Reservoir	1997REIRO0Q004
Total = 4				
Pocatello RO 10/14/97 -10/16/97				
Portneuf River (U)	10-14-97	17040208	Utah Bridge to Lava Hot Springs	1997RSEIROQ001
Portneuf River (UM)	10-14-97	17040208	Lava Hot Springs to MVC Diversion	1997RSEIROQ002
Portneuf River (M)	10-15-97	17040208	MVC Diversion to Marsh Creek	1997RSEIROQ003
Portneuf River (LM)	10-15-97	17040208	Marsh Creek to Johney Creek	1997RSEIROQ004
Blackfoot River (U)	10-16-97	17040207	Headwaters to Blackfoot Reservoir	1997RSEIROQ005
Blackfoot River (L)	10-16-97	17040207	Reservoir Dam to Wolverine Creek	1997RSEIROQ006
Total = 6				
Twin Falls RO 10/23/97 -10/29/97				
Snake River (Massacre)	10-23-97	17040206	Massacre Rocks to Lake Walcott	1997RSCIROQ001
Little Wood River (U)	10-24-97	17040221	Richfield (Town) to Big Wood River	1997RSCIROQ002
Snake River (Milner)	10-27-97	17040206	Lake Walcott Dam to Milner Dam	1997RSCIROQ003
Big Wood River (L)	10-28-97	17040219	Hwy 75 to Little Wood River	1997RSCIROQ004

Water Body	Date Sampled	HUC[1]	Boundaries	Site I.D.
Big Wood River (U)	10-29-97	17040219	Hwy 75 to Little Wood River	1997RSCIROQ005
Total = 5				
Total Sites Monitored = 31				

[1]HUC = Hydrologic Unit Catalog
[2]L = Lower
[3]M = Middle
[4]U = Upper

1998 RIVER BURP SITES

Water Body	Date Sampled	HUC	Boundaries	Site I.D.
Boise				
Weiser River	8-18-98	17050124	Galloway to Mouth	1998RBOIP001
Little Salmon River (U)[2]	8-19-98	17060210	Headwaters to Round Valley Creek	1998RBOIP002
South Fork Payette River	8-25-98	17050120	Headwaters to North Fork Payette River	1998RBOIP003
Snake River	8-26-98	17050115	Boise River to Weiser River	1998RBOIP004
South Fork Owyhee River	10-20-98	17050105	Nevada Line to Owyhee River	1998RBOIP005
Payette River	10-27-98	17050122	Black Canyon Dam to Mouth	1998RBOIP006
Total= 6				
Lewiston				
Little Salmon River	8-19-98	17060210	R1E T21N Sec 24 (Round Valley Creek) to Confluence with Salmon River	1998RLEWP001
Clearwater River	9-1-98	17060306	Hatwai Creek to Snake Confluence (area not on Nez Perce Reservation)	1998RLEWP002
Snake River (Asotin)	9-2-98	17060103	Lower Snake to Asotin	1998RLEWP003
Snake River (Grande Ronde)	9-3-98	17060103	Lower Snake to Asotin	1998RLEWP004
Total=4				
Coeur d'Alene				
Spokane River	9-16-98	17010305	Coeur d'Alene Lake to Heutter	1998RCDAP001
Spokane River	9-16-98	17010305	Heutter to Post Falls Bridge	1998RCDAP002
Spokane River	9-17-98	17010305	Washington State Line to Post Falls	1998RCDAP003
South Fork Coeur d'Alene River	9-17-98	17010302	Osborne to Coeur d'Alene River	1998RCDAP004
Moyie River	9-18-98	17010105	Moyie Falls Dam to Kootenai River	1998RCDAP005

Water Body	Date Sampled	HUC	Boundaries	Site I.D.
Clark Fork River	9-19-98	17010213	Clark Fork River (MT Border) to Lake Pend Oreille	1998RCDAP006
Priest River	9-20-98	17010215	Upper West Branch to Pend Oreille River	1998RCDAP007
Pend Oreille River	9-20-98	17010216	WA State Line to HUC Boundary- Albeni Falls Dam	1998RCDAP008
Coeur d'Alene River (I-90 Bridge)	9-21-98	17010303	Skeel Gulch to Latour Creek	1998RCDAP009
Coeur d'Alene River (Old Mission State Park)	9-21-98	17616303	French Gulch to Skeel Gulch	1998RCDAP0010
Coeur d'Alene River (Rose Bridge)	9-22-98	17010303	Fortier Creek to Fourth of July Creek	1998RCDAP0011
Coeur d'Alene River (Killarmey Lake)	9-22-98	17010303	Robinson Creek to Fortier Creek	1998RCDAP0012
Coeur d'Alene River (Cave Lake)	9-23-98	17010303	Cave Lake to Black Lake	1998RCDAP0013
Coeur d'Alene River (Black Lake)	9-23-98	17010303	Black Lake to Thompson Lake	1998RCDAP0014
Total = 14				
Idaho Falls				
Salmon River (U)	9-9-98	17060201	Hellroaring Creek to Redfish Lake Creek	1998RIDFP001
Salmon River (L)[3]	9-10-98	17060201	Redfish Lake Creek to East Fork Salmon River	1998RIDFP002
Teton River (U)	9-29-98	17040204	Headwaters to Trail Creek	1998RIDFP003
Teton River (Hwy 33)	9-29-98	17040204	Trail Creek to Hwy 33	1998RIDFP004
Salmon River (M)[4]	10-1-98	17060201	Redfish Lake Creek to East Fork Salmon River	1998RIDFP005
Total=5				
Pocatello				
Blackfoot River	10-5-98	17040207	Wolverine Creek to	1998RPOCP001

Water Body	Date Sampled	HUC	Boundaries	Site I.D.
			Snake River	
Bear River	10-6-98	16010102	Wyoming Line to Rocky Point	1998RPOCP002
Bear River	10-6-98	16010201	Rocky Point to Stewart Dam	1998RPOCP003
Bear River	10-7-98	16010202	Grace/Cove Dam to Oneida Reservoir	1998RPOCP004
Bear River	10-7-98	16010202	Riverdale to Utah Border	1998RPOCP005
Total=5				
Twin Falls				
Jarbidge River	10-13-98	17050102	Buck to East Fork Jarbidge River	1998RTWFP001
Bruneau River (Indian Hot Springs)	10-14-98	17050102	Nevada Line to Hot Creek	1998RTWFP002
Bruneau (@ Hwy 51)	10-15-98	17050102	Hot Creek to CJ Strike Reservoir	1998TWFP003
Bruneau River (U)	10-21-98	17050102	Nevada Border to Hot Creek	1998RTWFP004
Bruneau River (M)	10-22-98	17050102	Hot Creek to CJ Strike Reservoir	1998RTWFP005
Total=5				
TOTAL SITES=39				
TOTAL RIVERS=20				

[1]HUC = Hydrologic Unit Catalog
[2]L = Lower
[3]M = Middle
[4]U = Upper

Appendix B.
WATER BODY SIZE CRITERIA DATA WORKSHEETS

Key

(1) Drainage area above site
(2) Discharge from measurements (DEQ) or calculations using USGS data - see codes
Used calculated factor see (8)
(3) S = Calculation from flow on sampling date
L= Calculation from long term daily flow
M = No calculation-used measured flow
(4) Drainage area above gaging station
(5) Long-term daily flow for the month and day of the sampling date (data obtained from 1997 Earth Info CD: Extreme Value)
(6) Mean annual discharge for the period of record for the gage site
(7) Flow from gaging station
(8) Flow on sampling date or long-term daily flow (depending on data availability) divided by gaging station drainage area.

Discharge Worksheet

RIVER	SITE I.D.	(1) DRAINAGE AREA (mi2)	DATE SAMPLED	(2) DISCHG	CALC. DISCHG.	(3) CODE	DEQ = 1 USGS = 2 OTHER = 3
MF Boise R	1997RSWIROQ001	289	09/04/97	183	183	S	2
NF Boise R	1997RSWIROQ002	306	09/05/97	194	194	S	2
SF Boise R	1997RSWIROQ003	620	09/08/97	290	290	S	2
SF Salmon R	1997RSWIROQ004	366	09/10/97	194	194	S	2
EF SF Salmon R	1997RSWIROQ005	106	09/10/97	57	57	S	2
Portneuf R (U)	1997RSEIROQ001	330	10/14/97	77	77	L	2
Portneuf R (UM)	1997RSEIROQ002	588	10/14/97	138	138	L	2
Portneuf R (M)	1997RSEIROQ003	959	10/15/97	289	289	S	2
Portneuf R (LM)	1997RSEIROQ004	1120	10/15/97	338	338	S	2
Blackfoot R (U)	1997RSEIROQ005	186	10/16/97	47	47	L	2
Blackfoot R (L)	1997RSEIROQ006	650	10/16/97	174	174	L	2
Snake R (Massacre)	1997RSCIROQ001	15700	10/23/97	9,743	9,743	S	2
Little Wood R (U)	1997RSCIROQ002	769	10/24/97	210	210	L	2
Snake R (Milner)	1997RSCIROQ003	17180	10/27/97	10,002	10,002	S	2
Big Wood R (L)	1997RSCIROQ004	2755	10/28/97	492	492	S	2
Big Wood R (U)	1997RSCIROQ005	2755	10/29/97	492	492	S	2
SF Clearwater (L)	1997RNCIROQ001	1176	09/16/97	478	478	S	2
SF Clearwater (M)	1997RNCIROQ002	606	09/16/97	205	246	M	1
SF Clearwater (U)	1997RNCIROQ003	263	09/17/97	78	107	M	1
Lochsa R	1997RNCIROQ004	492	09/18/97	710	530	M	1
NF Coeur d'Alene R	1997RNIRO0Q001	306	09/24/97	119	119	S	2
Pend Oreille R	1997RNIRO0Q002	24200	09/25/97	12,700	12,700	S	2
Pack R	1997RNIRO0Q003	246	09/27/97	73	73	L	2
St. Marie's R	1997RNIRO0Q004	485	09/28/97	87	87	L	2
Coeur d'Alene R (Harrison)	1997RNIRO0Q005	1465	09/29/97	552	552	S	2
Coeur d'Alene R (Rose Lake)	1997RNIRO0Q006	1429	09/29/97	539	539	S	2
Coeur d'Alene R (Medimont)	1997RNIRO0Q007	1392	09/30/97	504	504	S	2
Falls R (L)	1997REIRO0Q001	370	10/07/97	260	260	S	2
Teton R (U)	1997REIRO0Q002	482	10/08/97	339	339	L	2
Henry's Fork (U)	1997REIRO0Q003	664	10/08/97	970	970	S	2
Henry's Fork (L)	1997REIRO0Q004	1388	10/09/97	2,029	2,029	S	2
Weiser R	1998RBOIP001	1777	08/18/98			S	2
Rapid River			08/19/98				
Little Salmon R (U)	1998RBOIP002	203	08/19/98				2
Little Salmon R (L)	1998RLEWP001	344	08/19/98				2
SF Payette R	1998RBOIP003	410	08/25/98				2
Snake R (Payette confluence	1998RBOIP004	58700	08/26/98				2
Clearwater R	1998RLEWP002	9346	09/01/98				2
Snake R (Asotin)	1998RLEWP003	92978	09/02/98				2
Grande Ronde			09/03/98				
Snake R (Grande Ronde)	1998RLEWP004	92960	09/03/98				2
Salmon R (U - Redfish Lk Cr)	1998RIDFP001	304	09/09/98				
Salmon R (L - Clayton)	1998RIDFP002	1149	09/10/98				
Spokane R (Blackwell Stn)	1998RCDAP001	646	09/16/98				2
Spokane R (Black Bay)	1998RCDAP002	826	09/16/98				2
Spokane R (Corbin Park)	1998RCDAP003	981	09/17/98				2
SF Coeur d'Alene R	1998RCDAP004	300	09/17/98		113	M	1
Moyie R	1998RCDAP005	755	09/18/98		94	M	1
Clark Fork R	1998RCDAP006	22132	09/19/98				2
Priest R	1998RCDAP007	782	09/20/98		327	M	1
Pend Oreille R	1998RCDAP008	2156	09/20/98				2
Coeur d'Alene R (I-90 Bridge)	1998RCDAP009	1214	09/21/98				2
Coeur d'Alene R (Cataldo)	1998RCDAP010	1218	09/21/98				2
Coeur d'Alene R (Rose Bridge	1998RCDAP011	1332	09/22/98				2
Coeur d'Alene R (Killarney Lk	1998RCDAP012	1362	09/22/98				2
Coeur d'Alene R (Cave Lake)	1998RCDAP013	1413	09/23/98				2
Coeur d'Alene R (Black Lake)	1998RCDAP014	1442	09/23/98				2
Teton R (Trail Creek)	1998RIDFP003	114	09/29/98		82	M	1

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Discharge Worksheet

RIVER	SITE I.D.	(1) DRAINAGE AREA (mi2)	DATE SAMPLED	(2) DISCHG	CALC. DISCHG.	(3) CODE	DEQ = 1 USGS = 2 OTHER = 3
Teton R (Hwy 33)	1998RIDFP004	431	09/29/98		334	M	1
Salmon R (M - O'Brien CG)	1998RIDFP005	818	10/01/98				
Blackfoot R	1998RPOCP001	948	10/05/98		269	M	1
Bear R (Thomas Fork Cr)	1998RPOCP002	2486	10/06/98				3
Bear R (Dingle Bridge)	1998RPOCP003	2810	10/06/98				3
Bear R (Cove Dam - Oneida)	1998RPOCP004	4241	10/07/98				3
Bear R (Hwy 36)	1998RPOCP005	4613	10/07/98				3
Jarbridge R	1998RTWFP001	180	10/13/98		49	M	1
Bruneau R (Indian Hot Spr)	1998RTWFP002	1039	10/14/98		77	M	1
Bruneau R (Hwy 51)	1998RTWFP003	3235	10/15/98		96	M	1
SF Owyhee R	1998RBOIP005	2777	10/20/98		63	M	1
Bruneau R (Homer Bedal)	1998RTWFP004	498	10/21/98		49	M	1
Bruneau R (Rec. Site)	1998RTWFP005	2605	10/22/98				2
Payette R	1998RBOIP006	3312	10/27/98				2

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Discharge Worksheet

RIVER	SITE I.D.	USGS INFORMATION GAGING STATION #	LOCATION	(4) DRAINAGE AREA (mi2)	PERIOD OF RECORD	(5) LT DAILY FLOW (cfs)	(6) MEAN ANNUAL DISCHARGE (cfs)	(7)FLOW ON SAMPLING DATE (cfs)	(8) USGS FACTOR (cfs/mi2)	COMMENTS Station near site, use data	Station near site, but requires extrapolation	Station near site, but older data	Mean Annual Dischg Factor	Site Mean Annual Discharge
MF Boise R	1997RSWIROQ001	13185000	Boise R. nr Twin Springs	830	1911-1997	365	1,182	526	0.6337		X		1.4241	412
NF Boise R	1997RSWIROQ002	13185000	Boise R. nr Twin Springs	830	1911-1997	365	1,182	526	0.6337		X		1.4241	436
SF Boise R	1997RSWIROQ003	13186000	SF Boise R. nr Featherville	635	1945-1996	228	761	297	0.4677		X		1.1984	743
SF Salmon R	1997RSWIROQ004	13310700	SF Salmon R. nr Krassel R.S.	330	1966-1997	147	527	175	0.5303	X			1.5970	584
EF SF Salmon R	1997RSWIROQ005	13313000	Johnson Creek at Yellow Pine	213	1928-1997	87	340	115	0.5399		X		1.5962	169
Portneuf R (U)	1997RSEIROQ001	13072000	Portneuf R. nr Pebble	260	1912-1977	61	109		0.2346		X	X	0.4192	138
Portneuf R (UM)	1997RSEIROQ002	13072000	Portneuf R. nr Pebble	260	1912-1977	61	109		0.2346		X	X	0.4192	247
Portneuf R (M)	1997RSEIROQ003	13075500	Portneuf R. at Pocatello	1250	1897-1996	197	277	377	0.3016		X		0.2216	213
Portneuf R (LM)	1997RSEIROQ004	13075500	Portneuf R. at Pocatello	1250	1897-1996	197	277	377	0.3016	X			0.2216	248
Blackfoot R (U)	1997RSEIROQ005	13063000	Blackfoot R. ab Res. nr Henry	350	1914-1982	89	168		0.2543		X	X	0.4800	89
Blackfoot R (L)	1997RSEIROQ006	13065500	Blackfoot R. nr Henry	583	1908-1925	156	245		0.2676		X	X	0.4202	273
Snake R (Massacre)	1997RSCIROQ001	13077000	Snake at Neely	13600	1907-1997	3,872	7,574	8,440	0.6206		X		0.5569	8744
Little Wood R (U)	1997RSCIROQ002	13151000	Little Wood R. nr Richfield	570	1911-1972	156	162		0.2737		X	X	0.2842	219
Snake R (Milner)	1997RSCIROQ003	13081500	Snake R. nr Minidoka at Howells Ferry	15700	1910-1997	3,618	6,575	9,140	0.5822	X			0.4188	7195
Big Wood R (L)	1997RSCIROQ004	13152500	Malad R. nr Gooding	2990	1916-1997	103	288	534	0.1786		X		0.0963	265
Big Wood R (U)	1997RSCIROQ005	13152500	Malad R. nr Gooding	2990	1916-1997	103	288	534	0.1786		X		0.0963	265
SF Clearwater (L)	1997RNCIROQ001	13338500	SF Clearwater at Stites	1150	1911-1997	266	1,019	467	0.4061	X			0.8861	1042
SF Clearwater (M)	1997RNCIROQ002	13338500	SF Clearwater at Stites	1150	1911-1997	266	1,019	467	0.4061				0.8861	537
SF Clearwater (U)	1997RNCIROQ003	13338500	SF Clearwater at Stites	1150	1911-1997	266	1,019	467	0.4061				0.8861	233
Lochsa R	1997RNCIROQ004	13337000	Lochsa R. nr Lowell	1180	1910-1997	597	2,806	1,270	1.0763				2.3780	1170
NF Coeur d'Alene R	1997RNIRO0Q001	12411000	NF CDA ab Shoshone nr Prichard	335	1950-1997	107	694	130	0.3881		X		2.0716	634
Pend Oreille R	1997RNIRO0Q002	12395500	Pend Oreille at Newport, WA	24200	1903-1996	14,162	25,130	12,700	0.5248				1.0384	25130
Pack R	1997RNIRO0Q003	12392390	Pack R. ab Rapid Lightning Creek	218.7	1988-1993	65	440		0.2972		X	X	2.0119	495
St. Marie's R	1997RNIRO0Q004	12415000	St. Maries at Lotus	437	1912-1966	78	518		0.1785		X	X	1.1854	575
Coeur d'Alene R (Harrison)	1997RNIRO0Q005	12413500	CDA R. at Cataldo	1223	1911-1997	415	2,526	461	0.3769		X		2.0654	3026
Coeur d'Alene R (Rose Lake)	1997RNIRO0Q006	12413500	CDA R. at Cataldo	1223	1911-1997	415	2,526	461	0.3769		X		2.0654	2951
Coeur d'Alene R (Medimont)	1997RNIRO0Q007	12413500	CDA R. at Cataldo	1223	1911-1997	415	2,526	443	0.3622		X		2.0654	2875
Falls R (L)	1997REIRO0Q001	13047500	Falls R. nr Squirell	326	1904-1997	713	773	229	0.7025		X		2.3712	877
Teton R (U)	1997REIRO0Q002	13054000	Teton R. nr Tetonia	471	1929-1957	331	394		0.7028		X	X	0.8365	403
Henry's Fork (U)	1997REIRO0Q003	13046000	Henry's Fork nr Ashton	1040	1890-1997	1,193	1,474	1,520	1.4615		X		1.4173	941
Henry's Fork (L)	1997REIRO0Q004	13046000	Henry's Fork nr Ashton	1040	1890-1997	1,193	1,474	1,520	1.4615		X		1.4173	1967
Weiser R	1998RBOIP001	13266000	Weiser River nr Weiser, ID	1460	1952-1997	203	1,110	317		X			0.7603	1351
Rapid River								150						
Little Salmon R (U)	1998RBOIP002	13316500	Little Salmon R @ Riggins, ID (-Rapid)	576	1956-1997	243	792	265			X		1.3750	279
Little Salmon R (L)	1998RLEWP001	13316500	Little Salmon R @ Riggins, ID (-Rapid)	576	1956-1997	243	792	265			X		1.3750	47
SF Payette R	1998RBOIP003	13235000	SF Payette R @ Lowman, ID	456	1941-1997	454	870	481					1.9079	782
Snake R (Payette confluence	1998RBOIP004	13269000	Snake R @ Weiser, ID	69200	1910-1997	9,960	18,200	12,500					0.2630	942
Clearwater R	1998RLEWP002	13342500	Clearwater R @ Spalding, ID	9570	1925-1997	3,910	15,430	2,910					1.6123	29
Snake R (Asotin)	1998RLEWP003	13334300	Snake R nr Anatone, WA	92960	1958-1997	17,450	CALL WASH.	USGS R.O.					0.0000	0
Grande Ronde		13333000	Grande Ronde @ Troy, OR	3275	1944-1997	782	3,005	627						0
Snake R (Grande Ronde)	1998RLEWP004	13334300	Snake R nr Anatone, WA (-GrRonde)	92960	1958-1997	17,690	CALL WASH.	USGS R.O.					0.0000	0
Salmon R (U - Redfish Lk Cr)	1998RIDFP001	13295500	Salmon R bl Valley Cr @ Stanley, ID	501	1925-1960	336	664	*336*					1.3253	403
Salmon R (L - Clayton)	1998RIDFP002	13296500	Salmon R bl Yankee Fk nr Clayton, ID	802	1921-1991	494	990	*494*					1.2344	1418
Spokane R (Blackwell Stn)	1998RCDAP001	12419000	Spokane R nr Post Falls, ID	3840	1913-1997	1,180	6,237	SP					1.6242	1049
Spokane R (Black Bay)	1998RCDAP002	12419000	Spokane R nr Post Falls, ID	3840	1913-1997	1,180	6,237	SP					1.6242	1341
Spokane R (Corbin Park)	1998RCDAP003	12419000	Spokane R nr Post Falls, ID	3840	1913-1997	1,194	6,237	SP					1.6242	1594
SF Coeur d'Alene R	1998RCDAP004	12413470	SF CDA R nr Pinehurst, ID	299	1987-1997	105	542	SP					1.8127	545
Moyie R	1998RCDAP005	12307500	Moyie R @ Eileen, ID	755	1925-1978	171	885	*171*					1.1722	885
Clark Fork R	1998RCDAP006	12392000	Clark Fork @ Whitehorse Rapids nr Cab	22073	1928-1997	10,416	22,250	SP						0
Priest R	1998RCDAP007	12395000	Priest R nr Priest River, ID	902	1929-1997	425	1,503	SP					1.6663	1303
Pend Oreille R	1998RCDAP008	12395500	Pend Oreille at Newport, WA	1511	1952-1997	--	--	17,700						0
Coeur d'Alene R (I-90 Bridge)	1998RCDAP009	12413500	CDA R at Cataldo, ID	1220	1986-1997	424	2,545	310					2.0861	2533
Coeur d'Alene R (Cataldo)	1998RCDAP010	12413500	CDA R at Cataldo, ID	1220	1986-1997	424	2,545	310					2.0861	2541
Coeur d'Alene R (Rose Bridge	1998RCDAP011	12413500	CDA R at Cataldo, ID	1220	1986-1997	426	2,545	310					2.0861	2779
Coeur d'Alene R (Killarney Lk	1998RCDAP012	12413500	CDA R at Cataldo, ID	1220	1986-1997	426	2,545	310					2.0861	2840
Coeur d'Alene R (Cave Lake)	1998RCDAP013	12413500	CDA R at Cataldo, ID	1220	1986-1997	424	2,545	310					2.0861	2948
Coeur d'Alene R (Black Lake)	1998RCDAP014	12413500	CDA R at Cataldo, ID	1220	1986-1997	424	2,545	310					2.0861	3009
Teton R (Trail Creek)	1998RIDFP003	13052200	Teton R abv S Leigh Cr nr Driggs, ID	335	1961-1997	324	406	334					1.2119	138

Discharge Worksheet

RIVER	SITE I.D.	USGS INFORMATION: GAGING STATION #	LOCATION	(4) DRAINAGE AREA (mi2)	PERIOD OF RECORD	(5) LT DAILY FLOW (cfs)	(6) MEAN ANNUAL DISCHARGE (cfs)	(7)FLOW ON SAMPLING DATE (cfs)	(8) USGS FACTOR (cfs/mi2)	COMMENTS: Station near site, use data	Station near site, but requires extrapolation	Station near site, but older data	Mean Annual Dischg Factor	Site Mean Annual Discharge
Teton R (Hwy 33)	1998RIDFP004	13052200	Teton R abv S Leigh Cr nr Driggs, ID	335	1961-1997	324	406	334					1.2119	522
Salmon R (M - O'Brien CG)	1998RIDFP005	13296500	Salmon R bl Yankee Fk nr Clayton, ID	802	1921-1991	498	990	*498*					1.2344	1010
Blackfoot R	1998RPOCP001	13068500	Blackfoot R nr Blackfoot, ID	1295	1940-1997	148	158	216					0.1220	116
Bear R (Thomas Fork Cr)	1998RPOCP002		Pacific Corp. @			?	?	485						0
Bear R (Dingle Bridge)	1998RPOCP003		Pacific Corp. ab Stewart Dam			?	?	504						0
Bear R (Cove Dam - Oneida)	1998RPOCP004		Pacific Corp. @ Thatcher			?	?	1,899						0
Bear R (Hwy 36)	1998RPOCP005		Pacific Corp. @ Preston			?	?	1,232						0
Jarbridge R	1998RTWFP001	13162200	Jarbidge R @ Jarbidge, NV	22.6	1964-1978	CALL NEVADA USGS R.O.								0
Bruneau R (Indian Hot Spr)	1998RTWFP002	13168500	Bruneau R nr Hot Spring, ID	2631	1943-1996	100	388	*100*					0.1475	153
Bruneau R (Hwy 51)	1998RTWFP003	13168500	Bruneau R nr Hot Spring, ID	2631	1943-1996	99	388	*99*					0.1475	477
SF Owyhee R	1998RBOIP005	13177800	SF Owyhee R nr Whiterock, NV	1080	1955-1981	CALL NEVADA USGS R.O.							0.0000	0
Bruneau R (Homer Bedal)	1998RTWFP004	13168500	Bruneau R nr Hot Spring, ID	2631	1943-1996	105	388	*105*					0.1475	73
Bruneau R (Rec. Site)	1998RTWFP005	13168500	Bruneau R nr Hot Spring, ID	2631	1943-1996	107	388	*107*					0.1475	384
Payette R	1998RBOIP006	13251000	Payette R nr Payette, ID	3240	1935-1997	1,526	3,048	1,320					0.9407	3116

Key

	ISU Criteria:			DEQ Criteria:			
	Order	Baseflow Width (m)	Average Baseflow Depth (m)	**Ave. Greatest D (m)**	**(1) Site Dischg (cfs)**	**(2) Site Mean Annual Dischg (cfs)**	**Site Drainage Area (mi2)**
Large	>6	30 - 180	0.4 - 1.8	>0.91	>164	>744	>971
Medium	5 -6	15 - 40	0.2 -0.5	0.31 - 0.90	33 - 163	74 - 743	107 - 970
Stream	<5	<15	<0.4	<.30	<32	<73	<106

Water Body Criteria Analysis

RIVER	SITE I.D.	Site Ref	Stream Order	Ave. WW (m)	Ave. Depth (m)	Ave. Greatest D (m)	(1) Site Dischg (cfs)	(2) Site Mean Annual Dischg (cfs)	Site Drainage Area (mi2)
Falls R (L)	1997REIRO0Q001	17	4	54.50	0.52	0.65	260	877	370
Teton R (U)	1997REIRO0Q002	18	4	32.17	0.46	0.72	339	403	482
Henry's Fork (U)	1997REIRO0Q003	19	4	58.40	0.68	0.33	970	941	664
Henry's Fork (L)	1997REIRO0Q004	20	5	69.33	0.56	0.78	2,029	1,967	1388
SF Clearwater (L)	1997RNCIROQ001	6	5	40.22	0.34	0.67	478	1,042	1176
SF Clearwater (M)	1997RNCIROQ002	7	5	30.63	0.35	0.63	205	537	606
SF Clearwater (U)	1997RNCIROQ003	8	5	17.53	0.32	0.62	78	233	263
Lochsa R	1997RNCIROQ004	9	5	45.62	0.50	0.73	710	1,170	492
NF Coeur d'Alene R	1997RNIRO0Q001	10	5	33.70	0.24	0.38	119	634	306
Pend Oreille R	1997RNIRO0Q002	11	7	565.50	11.70	21.13	12,700	25,130	24200
Pack R	1997RNIRO0Q003	12	4	25.83	0.47	1.03	73	495	246
St. Marie's R	1997RNIRO0Q004	13	5	37.33	3.02	4.89	87	575	485
Coeur d'Alene R (Harrison)	1997RNIRO0Q005	14	6	89.58	7.13	11.89	552	3,026	1465
Coeur d'Alene R (Rose Lake)	1997RNIRO0Q006	15	6	94.67	12.40	17.67	539	2,951	1429
Coeur d'Alene R (Medimont)	1997RNIRO0Q007	16	6	83.00	5.74	8.53	504	2,875	1392
Snake R (Massacre)	1997RSCIROQ001	27	7	226.83	5.31	7.94	9,743	8,744	15700
Little Wood R (U)	1997RSCIROQ002	28	5	11.93	0.45	0.58	210	219	769
Snake R (Milner)	1997RSCIROQ003	29	7	316.83	1.27	2.33	10,002	7,195	17180
Big Wood R (L)	1997RSCIROQ004	30	6	13.70	0.51	0.83	492	265	2755
Big Wood R (U)	1997RSCIROQ005	31	6	12.02	0.50	0.77	492	265	2755
Portneuf R (U)	1997RSEIROQ001	21	4	18.00	0.57	0.90	77	138	330
Portneuf R (UM)	1997RSEIROQ002	22	4	17.18	1.31	1.85	138	247	588
Portneuf R (M)	1997RSEIROQ003	23	5	15.75	1.18	1.72	289	213	959
Portneuf R (LM)	1997RSEIROQ004	24	5	16.60	1.04	1.27	338	248	1120
Blackfoot R (U)	1997RSEIROQ005	25	4	16.45	0.41	0.58	47	89	186
Blackfoot R (L)	1997RSEIROQ006	26	5	30.50	0.39	0.60	174	273	650
MF Boise R	1997RSWIROQ001	1	4	31.50	0.45	0.78	183	412	289
NF Boise R	1997RSWIROQ002	2	5	33.08	0.37	0.60	194	436	306
SF Boise R	1997RSWIROQ003	3	5	33.90	0.35	0.50	290	743	620
SF Salmon R	1997RSWIROQ004	4	5	29.95	0.32	0.55	194	584	366
EF SF Salmon R	1997RSWIROQ005	5	4	17.62	0.30	0.52	57	169	106
Weiser River	1998RBOIP001	32	6	35.90	0.22	0.45		1351	1777
Little Salmon River (Upper)	1998RBOIP002	33	5	17.81	0.69	1.22		279	203
South Fork Payette River	1998RBOIP003	35	4	27.17	0.48	0.73		782	410
Snake River	1998RBOIP004	36	7	173.83	2.00	3.67		15438	58700
South Fork Owyhee River	1998RBOIP005	67		20.17	0.31	0.7	63		2777
Payette River	1998RBOIP006	70	6	86.67	1.03	1.63		3116	3312
Spokane River (Blackwell Station)	1998RCDAP001	42	6	206.33	1.10	2.00		1049	646
Spokane River (Black Bay)	1998RCDAP002	43	6	263.83	1.62	2.39		1341	826
Spokane River (Corbin Park)	1998RCDAP003	44	6	71.67	0.54	0.95		1594	981
South Fork Coeur d'Alene River	1998RCDAP004	45	5	18.17	0.26	0.48	113	545	300
Moyie River	1998RCDAP005	46		20.83	0.31	0.60	94	885	755
Clark Fork River	1998RCDAP006	47		182.50	1.71	3.07		22309	22132
Priest River	1998RCDAP007	48		39.50	0.54	1.02	327	1303	782
Pend Oreille River	1998RCDAP008	49	7	400.80	2.19	4.33			2156
Coeur d'Alene River (I-90 Bridge)	1998RCDAP009	50	6	42.17	0.44	0.73		2533	1214
Coeur d'Alene River (Cataldo)	1998RCDAP010	51	6	48.50	1.34	2.23		2541	1218
Coeur d'Alene River (Rose Bridge)	1998RCDAP011	52	6	90.83	1.16	1.85		2779	1332
Coeur d'Alene River (Killarney Lake)	1998RCDAP012	53	6	77.00	1.21	2.54		2840	1362
Coeur d'Alene River (Cave Lake)	1998RCDAP013	54	6	81.17	1.31	2.26		2948	1413
Coeur d'Alene River (Black Lake)	1998RCDAP014	55	6	82	1.27	2.05		3009	1442
Salmon River (Upper)	1998RIDFP001	40	5	26.00	0.32	0.63		403	304
Salmon River (Lower--Clayton)	1998RIDFP002	41	5	43.83	0.72	1.03		1418	1149
Teton River (Upper)	1998RIDFP003	56	3	11.06	0.4	0.62	82	138	114
Teton River (Highway 33)	1998RIDFP004	57	4	32	0.39	0.83	334	522	431
Salmon River (Middle)	1998RIDFP005	58	5	34	0.5	0.83		1010	818
Little Salmon River (Lower)	1998RLEWP001	34	5	18.45	0.46	0.78		473	344
Clearwater River	1998RLEWP002	37		201.67	1.07	1.73		15069	9346
Snake River (Asotin)	1998RLEWP003	38	7	179.67	1.13	2.71			92978

Water Body Criteria Analysis

RIVER	SITE I.D.	Site Ref	Stream Order	Ave. WW (m)	Ave. Depth (m)	Ave. Greatest D (m)	(1) Site Dischg (cfs)	(2) Site Mean Annual Dischg (cfs)	Site Drainage Area (mi2)
Snake River (Grande Ronde)	1998RLEWP004	39	7	174.17	5.26	9.75			92960
Blackfoot River	1998RPOCP001	59	5	21.17	0.45	0.67	269	116	948
Bear River	1998RPOCP002	60		40.5	0.82	1.28			2486
Bear River	1998RPOCP003	61		24.67	0.63	0.97			2810
Bear River	1998RPOCP004	62		52.83	1.5	2.11			4241
Bear River	1998RPOCP005	63		45.83	0.67	1.1			4613
Jarbidge River	1998RTWFP001	64	4	11.02	0.25	0.45	46		180
Bruneau River at Indian Hot Springs	1998RTWFP002	65	6	16.38	0.25	0.45	77	153	1039
Bruneau River at Highway 51	1998RTWFP003	66	6	17.67	0.25	0.45	96	477	3235
Bruneau River (Upper)	1998RTWFP004	68	5	10.79	0.3	0.47	49	73	498
Bruneau River (Middle)	1998RTWFP005	69	6	22	0.48	0.78		384	2605
Bear River near Pegram	beap		6	27.58	0.86				
Bear River near Riverdale	bear		6	36.50	0.63				
Big Creek near Taylor Ranch	bigc		5	43.00	0.56		618		
Bitch Creek near Felt	bitc		3	19.00	0.27		68		
Blackfoot River below Dam	blac		5						
Big Lost near Chilly	blos		4	17.24	0.42		133		
Boise River near Twin Springs	bois		6	36.83	0.68				
Bruneau River at Hot Springs	brun		6	24.66	0.25		69		
Big Wood above Ketchum	bwok		4	14.82	0.38		69		
Big Wood at Stanton Crossing	bwos		4	16.42	0.19		33		
Coeur d'Alene near Cataldo	cdac		6	63.33	1.19				
Coeur d'Alene near Shoshone	cdas		5	38.53	0.33				
Clearwater below Lowell	clea		6	88.33	1.59				
East Fork Salmon River near Boulder	efsa		4	15.50	0.30		85		
Falls River near Marysville	fall		5	46.00	0.55				
Henry's Fork near Ashton	hena		5	73.08	0.83				
Henry's Fork near Island Park	henc		5	67.00	0.52				
Henry's Fork near Pinehaven	henp		5	90.50	0.63				
Lower Blackfoot River near Firth	lbla		5	18.53	0.55				
Lower Boise near Middleton	lboi		7	26.60	0.58				
Lochsa above Lowell	loch		5	76.00	0.67				
Little Salmon near Riggins	lsal		5	22.34	0.34		260		
Middle Fork Salmon near Indian Cr.	mfsa		6	38.00	0.56		663		
Owyhee River near Battle Cr.	owyh		6	15.03	0.32				
Panther Creek near mouth	pant		5	10.50	0.40		118		
South Fork Payette R. near Garden V	paye		5	42.00	0.73				
Portneuf River above Lava	port		4						
Priest River below Lake	prie		5						
Running Creek near confluence	runn		4	7.60	0.27		32		
Rush Creek near Taylor Ranch	rush		4	9.00	0.27		69		
Salmon River near Challis	salc		6	48.40	0.45				
Salmon River near Deadwater	sald		7	75.00	0.78				
Salmon River near Yankee Fork	saly		6	25.70	0.57				
Selway above Lowell	selw		6	56.33	0.82				
South Fork Boise R. above Feathervi	sfbo		5	29.86	0.32		261		
South Fork Coeur d'Alene at confluen	sfcd		5	15.00	0.37		152		
South Fork Salmon River at Krassel	sfsa		5	28.50	0.44		122		
South Fork Snake near Heise	sfsn		7	126.67	0.87				
Snake at Buhl	snab		7	183.33	1.78				
Snake at King Hill	snak		7	114.17	1.78				
Snake near Blackfoot	snbl		7						
St. Joe at Avery	stja		5	37.83	0.35		241		
St. Joe at Calder	stjc		5	46.83	0.48				
Upper Coeur d'Alene	ucda		5	39.78	0.32		114		
Upper Lochsa near Powell	uloc		5	25.22	0.29		100		
Upper Salmon near Decker Flats	usal		5	24.10	0.48		108		
Upper Selway near Running Creek	usel		5	37.00	0.37		203		
Valley Creek above Stanley	vall		4	13.96	0.34		91		
Weiser below Cambridge	weis		5	33.08	0.35		102		

Water Body Criteria Analysis

RIVER	SITE I.D.	Site Ref	Stream Order	Ave. WW (m)	Ave. Depth (m)	Ave. Greatest D (m)	(1) Site Dischg (cfs)	(2) Site Mean Annual Dischg (cfs)	Site Drainage Area (mi2)
	MIN.		3.00	7.60	0.19	0.33	32.37	73.38	106.00
	MAX		7.00	565.50	12.40	21.13	12700.00	25130.00	92978.00
	AVG.		5.29	61.18	1.05	2.22	747.23	2458.60	5778.29
	MEDIAN		5.00	34.00	0.51	0.83	162.79	743.02	970.00
	STDS		0.96	80.19	1.82	3.69	2288.51	4936.98	17129.61

Water Body Criteria Analysis

RIVER	SITE I.D.	(3) ISU Criteria Analysis: Order	Baseflow Width	Average Baseflow Depth	DEQ Additional Criteria: Site Mean Annual Discharge		Site Drainage Area		Average Greatest Depth at Baseflow	DEQ Addl Criteria Ave.	DEQ Addl CriteriaRiver Size Class	ISU Criteria Ave.	ISU Criteria River Size Class		River Size Class (ISU designated)	All Criteria Ave.	All Criteria River Size Class	DEQ Addl CriteriaRiver Size Class	ISU Criteria River Size Class
Falls R (L)	1997REIRO0Q001	1	3	3	3	2	2			2.3	L	2.3	L	N	A	2.3	L	L	L
Teton R (U)	1997REIRO0Q002	1	2.5	2.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
Henry's Fork (U)	1997REIRO0Q003	1	3	3	3	2	2			2.3	L	2.3	L	N	A	2.3	L	L	L
Henry's Fork (L)	1997REIRO0Q004	2	3	3	3	3	2			2.7	L	2.7	L	N	A	2.7	L	L	L
SF Clearwater (L)	1997RNCIROQ001	2	3	1.5		3		3	2	2.7	L	2.2	L		NA	2.4	L	L	L
SF Clearwater (M)	1997RNCIROQ002	2	2.5	1.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
SF Clearwater (U)	1997RNCIROQ003	2	2	1.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
Lochsa R	1997RNCIROQ004	2	3	3	3	2	2			2.3	L	2.7	L	N	A	2.5	L	L	L
NF Coeur d'Alene R	1997RNIRO0Q001	2	2.5	1.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
Pend Oreille R	1997RNIRO0Q002	3	3	3	3	3	3			3.0	L	3.0	L	N	A	3.0	L	L	L
Pack R	1997RNIRO0Q003	1	2	2.5		2		2	3	2.3	L	1.8	M		NA	2.1	L	L	M
St. Marie's R	1997RNIRO0Q004	2	2.5	3	2	2	3			2.3	L	2.5	L	N	A	2.4	L	L	L
Coeur d'Alene R (Harrison)	1997RNIRO0Q005	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene R (Rose Lake)	1997RNIRO0Q006	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene R (Medimont)	1997RNIRO0Q007	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Snake R (Massacre)	1997RSCIROQ001	3	3	3	3	3	3			3.0	L	3.0	L	N	A	3.0	L	L	L
Little Wood R (U)	1997RSCIROQ002	2	1	2.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
Snake R (Milner)	1997RSCIROQ003	3	3	3	3	3	3			3.0	L	3.0	L	N	A	3.0	L	L	L
Big Wood R (L)	1997RSCIROQ004	2	1	3	2	3	2			2.3	L	2.0	L	N	A	2.2	L	L	L
Big Wood R (U)	1997RSCIROQ005	2	1	2.5		2		3	2	2.3	L	1.8	M		NA	2.1	L	L	M
Portneuf R (U)	1997RSEIROQ001	1	2	3	2	2	2			2.0	L	2.0	L	N	A	2.0	L	L	L
Portneuf R (UM)	1997RSEIROQ002	1	2	3	2	2	3			2.3	L	2.0	L	N	A	2.2	L	L	L
Portneuf R (M)	1997RSEIROQ003	2	2	3	2	2	3			2.3	L	2.3	L	N	A	2.3	L	L	L
Portneuf R (LM)	1997RSEIROQ004	2	2	3	2	3	3			2.7	L	2.3	L	N	A	2.5	L	L	L
Blackfoot R (U)	1997RSEIROQ005	1	2	2.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
Blackfoot R (L)	1997RSEIROQ006	2	2.5	1.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
MF Boise R	1997RSWIROQ001	1	2.5	2.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
NF Boise R	1997RSWIROQ002	2	2.5	1.5		2		2	2	2.0	L	2.0	L		NA	2.0	L	L	L
SF Boise R	1997RSWIROQ003	2	2.5	1.5		3		2	2	2.3	L	2.0	L		NA	2.2	L	L	L
SF Salmon R	1997RSWIROQ004	2	2	1.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
EF SF Salmon R	1997RSWIROQ005	1	2	1.5		2		2	2	2.0	L	1.5	M		NA	1.8	M	L	M
Weiser River	1998RBOIP001	2	2	1.5		3		3	2	2.7	L	1.8	M		NA	2.3	L	L	M
Little Salmon River (Upper)	1998RBOIP002	2	2	3	2	2	3			2.3	L	2.3	L	N	A	2.3	L	L	L
South Fork Payette River	1998RBOIP003	1	2	2.5		3		2	2	2.3	L	1.8	M		NA	2.1	L	L	M
Snake River	1998RBOIP004	3	3	3	3	3	3			3.0	L	3.0	L	N	A	3.0	L	L	L
South Fork Owyhee River	1998RBOIP005	1	2	1.5				3	2	2.5	L	1.5	M		NA	1.9	M	L	M
Payette River	1998RBOIP006	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Spokane River (Blackwell Station)	1998RCDAP001	2	3	3	3	2	3			2.7	L	2.7	L	N	A	2.7	L	L	L
Spokane River (Black Bay)	1998RCDAP002	2	3	3	3	2	3			2.7	L	2.7	L	N	A	2.7	L	L	L
Spokane River (Corbin Park)	1998RCDAP003	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
South Fork Coeur d'Alene River	1998RCDAP004	2	2	1.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
Moyie River	1998RCDAP005		2	1.5		3		2	2	2.3	L	1.8	x		NA	2.1	L	L	x
Clark Fork River	1998RCDAP006		3	3	3	3	3			3.0	L	3.0	x		NA	3.0	L	L	x
Priest River	1998RCDAP007		2.5	3	3	2	3			2.7	L	2.8	x		NA	2.7	L	L	x
Pend Oreille River	1998RCDAP008	3	3	3				3	3	3.0	L	3.0	L		NA	3.0	L	L	L
Coeur d'Alene River (I-90 Bridge)	1998RCDAP009	2	3	2.5		3		3	2	2.7	L	2.5	L		NA	2.6	L	L	L
Coeur d'Alene River (Cataldo)	1998RCDAP010	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene River (Rose Bridge)	1998RCDAP011	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene River (Killarney Lake)	1998RCDAP012	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene River (Cave Lake)	1998RCDAP013	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Coeur d'Alene River (Black Lake)	1998RCDAP014	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Salmon River (Upper)	1998RIDFP001	2	2	1.5		2		2	2	2.0	L	1.8	M		NA	1.9	M	L	M
Salmon River (Lower--Clayton)	1998RIDFP002	2	3	3	3	3	3			3.0	L	2.7	L	N	A	2.8	L	L	L
Teton River (Upper)	1998RIDFP003	1	1	2.5		2		2	2	2.0	L	1.5	M		NA	1.8	M	L	M
Teton River (Highway 33)	1998RIDFP004	1	2.5	1.5		2		2	2	2.0	L	1.7	M		NA	1.8	M	L	M
Salmon River (Middle)	1998RIDFP005	2	2.5	2.5		3		2	2	2.3	L	2.3	L		NA	2.3	L	L	L
Little Salmon River (Lower)	1998RLEWP001	2	2	2.5		2		2	2	2.0	L	2.2	L		NA	2.1	L	L	L
Clearwater River	1998RLEWP002		3	3	3	3	3			3.0	L	3.0	x		NA	3.0	L	L	x
Snake River (Asotin)	1998RLEWP003	3	3	3				3	3	3.0	L	3.0	L		NA	3.0	L	L	L

Water Body Criteria Analysis		(3) ISU Criteria Analysis			DEQ Additional Criteria												
RIVER	SITE I.D.	Order	Baseflow Width	Average Baseflow Depth	Site Mean Annual Discharge	Site Drainage Area	Average Greatest Depth at Baseflow	DEQ Addl Criteria Ave.	DEQ Addl CriteriaRiver Size Class	ISU Criteria Ave.	ISU Criteria River Size Class	River Size Class (ISU designated)	All Criteria Ave.	All Criteria River Size Class	DEQ Addl CriteriaRiver Size Class	ISU Criteria River Size Class
Snake River (Grande Ronde)	1998RLEWP004	3	3	3		3	3	3.0	L	3.0	L	NA	3.0	L	L	L
Blackfoot River	1998RPOCP001	2	2	2.5	2	2	2	2.0	L	2.2	L	NA	2.1	L	L	L
Bear River	1998RPOCP002		3	3		3	3	3.0	L	3.0	x	NA	3.0	L	L	x
Bear River	1998RPOCP003		2	3		3	3	3.0	L	2.5	x	NA	2.8	L	L	x
Bear River	1998RPOCP004		3	3		3	3	3.0	L	3.0	x	NA	3.0	L	L	x
Bear River	1998RPOCP005		3	3		3	3	3.0	L	3.0	x	NA	3.0	L	L	x
Jarbidge River	1998RTWFP001	1	1	1.5		2	2	2.0	L	1.2	M	NA	1.5	M	L	M
Bruneau River at Indian Hot Springs	1998RTWFP002	2	2	1.5	2	3	2	2.3	L	1.8	M	NA	2.1	L	L	M
Bruneau River at Highway 51	1998RTWFP003	2	2	1.5	2	3	2	2.3	L	1.8	M	NA	2.1	L	L	M
Bruneau River (Upper)	1998RTWFP004	2	1	1	2 2	2		2.0	L	1.3	M	NA	1.7	M	L	M
Bruneau River (Middle)	1998RTWFP005	2	2	2.5	2	3	2	2.3	L	2.2	L	NA	2.3	L	L	L
Bear River near Pegram	beap	2	2	3						2.3	L	L	2.3	L		L
Bear River near Riverdale	bear	2	2.5	3						2.5	L	L	2.5	L		L
Big Creek near Taylor Ranch	bigc	2	3	3						2.7	L	L	2.7	L		L
Bitch Creek near Felt	bitc	1	2	1.5						1.5	M	M	1.5	M		M
Blackfoot River below Dam	blac	2								2.0	x M		2.0	L		x
Big Lost near Chilly	blos	1	2	2.5						1.8	M	M	1.8	M		L
Boise River near Twin Springs	bois	2	2.5	3						2.5	L	L	2.5	L		L
Bruneau River at Hot Springs	brun	2	2	1.5						1.8	M	M	1.8	M		M
Big Wood above Ketchum	bwok	1	1	1.5						1.2	M	M	1.2	M		M
Big Wood at Stanton Crossing	bwos	1	2	1						1.3	M	M	1.3	M		M
Coeur d'Alene near Cataldo	cdac	2	3	3						2.7	L	L	2.7	L		L
Coeur d'Alene near Shoshone	cdas	2	2.5	1.5						2.0	L	L	2.0	L		M
Clearwater below Lowell	clea	2	3	3						2.7	L	L	2.7	L		L
East Fork Salmon River near Boulder	efsa	1	2	1.5						1.5	M	M	1.5	M		M
Falls River near Marysville	fall	2	3	3						2.7	L	L	2.7	L		L
Henry's Fork near Ashton	hena	2	3	3						2.7	L	L	2.7	L		L
Henry's Fork near Island Park	henc	2	3	3						2.7	L	L	2.7	L		L
Henry's Fork near Pinehaven	henp	2	3	3						2.7	L	L	2.7	L		L
Lower Blackfoot River near Firth	lbla	2	2	3						2.3	L	M	2.3	L		L
Lower Boise near Middleton	lboi	3	2	3						2.7	L	L	2.7	L		L
Lochsa above Lowell	loch	2	3	3						2.7	L	L	2.7	L		L
Little Salmon near Riggins	lsal	2	2	1.5						1.8	M	M	1.8	M		M
Middle Fork Salmon near Indian Cr.	mfsa	2	2.5	3						2.5	L	L	2.5	L		L
Owyhee River near Battle Cr.	owyh	2	2	1.5						1.8	M	L	1.8	M		M
Panther Creek near mouth	pant	2	1	2.5						1.8	M	M	1.8	M		M
South Fork Payette R. near Garden V	paye	2	3	3						2.7	L	L	2.7	L		L
Portneuf River above Lava	port	1								1.0	x M		1.0	M		x
Priest River below Lake	prie	2								2.0	x M		2.0	L		x
Running Creek near confluence	runn	1	1	1.5						1.2	M	M	1.2	M		M
Rush Creek near Taylor Ranch	rush	1	1	1.5						1.2	M	M	1.2	M		M
Salmon River near Challis	salc	2	3	2.5						2.5	L	L	2.5	L		L
Salmon River near Deadwater	sald	3	3	3						3.0	L	L	3.0	L		L
Salmon River near Yankee Fork	saly	2	2	3						2.3	L	L	2.3	L		L
Selway above Lowell	selw	2	3	3						2.7	L	L	2.7	L		L
South Fork Boise R. above Feathervi	sfbo	2	2	1.5						1.8	M	M	1.8	M		M
South Fork Coeur d'Alene at confluen	sfcd	2	2	1.5						1.8	M	M	1.8	M		M
South Fork Salmon River at Krassel	sfsa	2	2	2.5						2.2	L	L	2.2	L		L
South Fork Snake near Heise	sfsn	3	3	3						3.0	L	L	3.0	L		L
Snake at Buhl	snab	3	3	3						3.0	L	L	3.0	L		L
Snake at King Hill	snak	3	3	3						3.0	L	L	3.0	L		L
Snake near Blackfoot	snbl	3								3.0	x L		3.0	L		x
St. Joe at Avery	stja	2	2.5	1.5						2.0	L	L	2.0	L		M
St. Joe at Calder	stjc	2	3	2.5						2.5	L	L	2.5	L		L
Upper Coeur d'Alene	ucda	2	2.5	1.5						2.0	L	M	2.0	L		M
Upper Lochsa near Powell	uloc	2	2	1.5						1.8	M	M	1.8	M		M
Upper Salmon near Decker Flats	usal	2	2	2.5						2.2	L	M	2.2	L		L
Upper Selway near Running Creek	usel	2	2.5	1.5						2.0	L	L	2.0	L		M
Valley Creek above Stanley	vall	1	1	1.5						1.2	M	M	1.2	M		M
Weiser below Cambridge	weis	2	2	1.5						1.8	M	M	1.8	M		M

Water Body Criteria Analysis		(3) ISU Criteria Analysis			DEQ Additional Criteria											
RIVER	SITE I.D.	Order	Baseflow Width	Average Baseflow Depth	Site Mean Annual Discharge	Site Drainage Area	Average Greatest Depth at Baseflow	DEQ Addl Criteria Ave.	DEQ Addl CriteriaRiver Size Class	ISU Criteria Ave.	ISU Criteria River Size Class	River Size Class (ISU designated)	All Criteria Ave.	All Criteria River Size Class	DEQ Addl CriteriaRiver Size Class	ISU Criteria River Size Class
	MIN.	1.00	1.00	1.00	0.00	0.00	0.00	2.00		1.00			1.00			0.00
	MAX	3.00	3.00	3.00	3.00	3.00	3.00	3.00		3.00			3.00			0.00
	AVG.	1.91	2.39	2.43	1.29	1.47	1.45	2.51		2.25			2.31			0.00
	MEDIAN	2.00	2.50	3.00	2.00	2.00	2.00	2.33		2.33			2.33			0.00
	STDS	0.56	0.63	0.69	1.31	1.29	1.28	0.41		0.52			0.50			0.00

Appendix C.
RMI DATA

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
Snake R (Massacre)	1997RSCIROQ001		1.83	14	5	L	O
Snake R (Milner)	1997RSCIROQ003		3.77	18	9	L	O
Teton R (U)	1997REIRO0Q002		4.29	18	19	L	O
Big Wood R (L)	1997RSCIROQ004		3.47	10	19	L	R
Falls R (L)	1997REIRO0Q001		4.38	14	21	L	R
Henry's Fork (L)	1997REIRO0Q004		3.72	14	19	L	R
Henry's Fork (U)	1997REIRO0Q003		4.28	18	21	L	R
Lochsa R	1997RNCIROQ004		4.92	20	23	L	R
MF Boise R (T1)	1997RSWIROQ001A		4.95	24	23	L	R
MF Boise R (T4)	1997RSWIROQ001B		4.53	20	23	L	R
MF Boise R (T6)	1997RSWIROQ001C		4.88	20	23	L	R
NF Boise R	1997RSWIROQ002		4.83	18	21	L	R
Portneuf R (U)	1997RSEIROQ001		4.44	18	21	L	R
SF Boise R (T1)	1997RSWIROQ003A		4.51	16	21	L	R
SF Boise R (T4)	1997RSWIROQ003B		4.38	14	23	L	R
SF Boise R (T6)	1997RSWIROQ003C		4.67	14	21	L	R
SF Clearwater (L)	1997RNCIROQ001		4.01	20	17	L	R
SF Clearwater (M)	1997RNCIROQ002		4.80	18	21	L	R
Selway R	ISU1997VR1				23	L	R
Big Cr	ISU1997VR2				23	L	R
MF Salmon R	ISU1997VR3				23	L	R
Falls	1995ISU3				19	L	R
Henrys@Coffe	1995ISU4				21	L	R
Henrys@Pine	1995ISU5				21	L	R
Henrys@Ash	1995ISU6				13	L	R
Snake@Heise	1995ISU7				12	L	R
Owhyee	1995ISU10				21	L	R
Salmon@Y	1995ISU11				23	L	R
Salmon@Dead	1995ISU12				17	L	R
Salmon@Chall	1995ISU13				23	L	R
SF Payette	1995ISU14				21	L	R
MF Boise	1995ISU15				21	L	R
Selway	1995ISU16				21	L	R
Lochsa	1995ISU17				23	L	R
MF Clear	1995ISU18				21	L	R
CDA@Shosh	1995ISU19				21	L	R

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
St Joe@Calder	1995ISU21				21	L	R
StJoe@Avery	1995ISU22				23	L	R
Blackfoot R (L)	1997RSEIROQ006		3.69	16	19	L	T
Coeur d'Alene R (Harrison)	1997RNIRO0Q005		1.93	10	13	L	T
Coeur d'Alene R (Medimont)	1997RNIRO0Q007		2.74	10	11	L	T
Coeur d'Alene R (Rose Lake)	1997RNIRO0Q006		2.27	14	7	L	T
NF Coeur d'Alene R	1997RNIRO0Q001		3.48	22	15	L	T
Pend Oreille R	1997RNIRO0Q002		2.27	10	11	L	T
Portneuf R (LM)	1997RSEIROQ004		3.64	16	17	L	T
Portneuf R (M)	1997RSEIROQ003		0.55	14	5	L	T
Portneuf R (UM)	1997RSEIROQ002		2.50	10	15	L	T
St. Marie's R	1997RNIRO0Q004		2.57	10	15	L	T
Snake R, Bingham Co	ISU1997VD1				15	L	T
SF Salmon R	ISU1997VD2				23	L	T
Boise R, Canyon Co	ISU1997VD3				15	L	T
Bear@Pea	1995ISU1				13	L	T
Bear@Riv	1995ISU2				11	L	T
Snake@Buhl	1995ISU8				7	L	T
Snake@King	1995ISU9				7	L	T
CDA@Cat	1995ISU20				7	L	T
BEAR CREEK	1996SIDFY031	96EIROY031	5.13	18	21	M	O
BIRCH CREEK (MIDDLE)	1995SIDF0B32	95EIRO0B32	4.06	10	15	M	O
BREAKFAST CREEK (LOWER)	1997SLEWB22	97NCIROB22	4.27	20	23	M	O
CLEAR CREEK (MIDDLE)	1996SLEWC17	96NCIROC17	5.06	26	23	M	O
DEEP CREEK (LOWER)	1996SBOIB018	96SWIROB18	3.50	8	21	M	O
DEEP CREEK (LOWER)	1997SBOIA031	97SWIROA31	3.03	8	17	M	O
EAST FORK WOOD RIVER	1996STWFA049	96SCIROA49	5.27	14	21	M	O
GOOSE CREEK (LOWER)	1997STWFA069	97SCIROA69	3.89	14	19	M	O
LIME CREEK (LOWER)	1996SBOIB038	96SWIROB38	3.21	14	13	M	O

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
LITTLE WOOD RIVER	1996STWFB017	96SCIROB17	3.38	18	19	M	O
LITTLE WOOD RIVER (UPPER)	1996STWFA048	96SCIROA48	4.41	16	21	M	O
LONG MEADOW CREEK	1997SLEWB17	97NCIROB17	4.18	14	23	M	O
LOOP CREEK (UPPER)	1997SCDAA29	97NIRO0A29	4.82	24	21	M	O
MEDICINE LODGE (MIDDLE)	1994SIDF0067	94EIRO0067	3.36	10	19	M	O
MIDDLE FORK PAYETTE RIVER	1997SBOIB072	97SWIROB72	3.67	10	23	M	O
MORES CREEK (LOWER MID)	1996SBOIA054	96SWIROA54	2.85	12	15	M	O
MORES CREEK (LOWER)	1996SBOIA079	96SWIROA79	4.14	10	21	M	O
NF ST JOE RIVER	1997SCDAA36	97NIRO0A36	3.92	20	19	M	O
RAINEY CREEK	1996SIDFZ023	96EIROZ023	4.96	18	23	M	O
SAWMILL CREEK (LOWER)	1995SIDF0B38	95EIRO0B38	4.55	14	13	M	O
SQUAW CREEK	1994SIDF00042	94EIRO0042	4.55	18	23	M	O
SQUAW CREEK (UPPER)	1997SIDF00041	97EIRO0041	3.13	16	21	M	O
SQUAW CREEK (UPPER)	1995SIDF0A70	95EIRO0A70	4.07	16	23	M	O
WILLOW CREEK (LOWER)	1995SIDF0B70	95EIRO0B70	3.59	10	17	M	O
WILLOW CREEK (UPPER)	1995SIDFB072	95EIROB072	4.22	12	19	M	O
WILLOW CREEK (UPPER)	1995SIDFB068	95EIROB068	3.64	14	17	M	O
WOLF CREEK	1997SLEWB19	97NCIROB19	3.86	12	17	M	O
Blackfoot R (U)	1997RSEIROQ005		3.92	14	21	M	O
BEAR VALLEY CREEK	1997SIDFM085	97EIROM085	5.52	24	21	M	R
BEAR VALLEY CREEK (LOWER)	1997SBOIA063	97SWIROA63	3.47	14	17	M	R
BIG ELK CREKK	1996SIDFZ124	96EIROZ124	4.81	24	21	M	R

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
BIG SMOKEY CREEK	1997STWFA056	97SCIROA56	5.33	16	23	M	R
BITCH CREEK	1996SIDFZ130	96EIROZ130	4.44	10	23	M	R
BITCH CREEK	1996SIDFZ131	96EIROZ131	4.19	18	21	M	R
EAST FORK WOOD RIVER (UPPER)	1996STWFA051	96SCURIA51	5.17	26	21	M	R
FEATHER RIVER (LOWER)	1996SBOIA064	96SWIROA64	4.91	20	23	M	R
FEATHER RIVER (UPPER)	1996SBOIA063	96SWIROA63	4.15	16	21	M	R
INDEPENDENCE CREEK (LOWER)	1997SCDAA18	97NIRO0A18	3.52	12	15	M	R
JARBIDGE RIVER	1997STWFA032	97SCIROA32	3.16	10	17	M	R
NORTH FORK BIG WOOD RIVER	1996STWFA043	96SCIROA43	4.49	14	23	M	R
NUGGET CREEK	1997SCDAA27	97NIRO0A27	3.82	16	15	M	R
OLSON CREEK	1997SCDAA40	97NIRO0A40	4.93	22	23	M	R
PALISADES CREEK	1996SIDF0Z125	96EIROZ125	4.95	26	23	M	R
PANTHER CREEK	1995SIDFB040	95EIROB040	5.09	22	23	M	R
SHAFER CREEK (LOWER)	1996SBOIA046	96SWIROA46	3.71	14	19	M	R
SQUAW CREEK (UPPER)	1995SIDF0A69	95EIRO0A69	4.69	16	23	M	R
TRINITY CREEK (LOWER)	1996SBOIA056	96SWIROA56	4.52	20	19	M	R
WILLOW CREEK	1997SIDFM03	97EIROM003	3.54	8	19	M	R
Bear R.		93SWIRO38	4.12	18	23	M	R
Big Wood River		95SCIROA66	4.11		21	M	R
Boise R., NF		94SWIROA26	4.34	16	21	M	R
Boise R., SF@Abbotts		95SWIROA56	4.6	16	23	M	R
Burneau R.		93SWIRO48	4.43	22	23	M	R
Camas Cr		EIROM090	5.27	22	23	M	R
Deadwood R.		93SWIRO24	3.89	20	23	M	R
EF Salmon		EIROl104	3.75	14	19	M	R
Gold Fork R.		94SWIROB04	4.80	20	23	M	R

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
Hughes Cr		95niro050	4.1	14	23	M	R
Hughes Cr		95niro051	4.85	22	23	M	R
Hyndman Creek		96SCIROB28	3.57		13	M	R
Marsh Cr		EIROm147	4.34	14	23	M	R
MF East R		96niroa16	4.2	18	23	M	R
NF Salmon R		EIROm64	4.73	26	23	M	R
Owyhee R., NF		95SWIROB08	3.64	12	21	M	R
Roaring R.		96swiroa60	4.59	24	19	M	R
Ross Fork Creek		96SCIROA41	4.98		21	M	R
Ross Fork Creek		96SCIROA39	3.52		19	M	R
Salmon R@Hellroaring		EIROA75	3.08	14	21	M	R
Secesh R.		95swiroc12	4.41	18	23	M	R
Smith Cr		94niro036	4.02	16	19	M	R
South Fork Boise River		95SCIROA76	3.95		21	M	R
South Fork Boise River		95SCIROA67	4.17		21	M	R
South Fork Boise River		95SCIROA76	3.95		21	M	R
South Fork Boise River		95SCIROA67	4.17		21	M	R
Upper Priest		94niro21	4.77	24	23	M	R
Upper Priest		94niro22	4.59	22	23	M	R
Upper St Joe		94niro051	5	26	23	M	R
Upper St Joe		94niro050	4.28	14	23	M	R
Warm River		EIROM75	5.42	14	23	M	R
Wildhorse R.		94SWIROA33	5.46	24	23	M	R
Big Wood R (U)	1997RSCIROQ005		3.42	10	13	M	R
EF SF Salmon R (T1)	1997RSWIROQ005A		5.19	26	21	M	R
EF SF Salmon R (T3)	1997RSWIROQ005B		5.08	26	21	M	R
EF SF Salmon R (T6)	1997RSWIROQ005C		5.76	30	21	M	R
SF Clearwater (U)	1997RNCIROQ003		4.92	22	23	M	R
SF Salmon R	1997RSWIROQ004		4.86	22	23	M	R
Priest R	ISU1996R1			21	21	M	R
NF CD'A	ISU1996R2			25	23	M	R
Lochsa	ISU1996R3			29	23	M	R
Little Salmon	ISU1996R4			19	23	M	R
Salmon + Stanley	ISU1996R5			31	23	M	R
EF Salmon	ISU1996R6			29	21	M	R
Valley Cr	ISU1996R7			33	23	M	R

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
SF Boise	ISU1996R8			31	23	M	R
Big Wood R+ Ketchum	ISU1996R9			33	21	M	R
Big Lost R + Chilly	ISU1996R10			33	21	M	R
Bitch	1997ISU			21		M	R
Running	1997ISU			19		M	R
Rush	1997ISU			17		M	R
Beaver Cr		EIROB63	1.13	18	5	M	T
Big Lost@Moore (L)		EIROa102	1.81	18	7	M	T
Big Lost@Moore (U)		EIROA103	2.29	18	7	M	T
Billingsley Creek		94SCIRO024	2.56		9	M	T
Boise@Caldwell		95SWIROC30	2.02	10	7	M	T
Boise@Notus		95SWIROC29	2.92	12	9	M	T
Boise@Star		95SWIROC31	3.13	16	9	M	T
Deep Creek		96SCIROB47	1.08		11	M	T
Lightning		94niro023	4.68	16	21	M	T
NF CD'A		96nirob03	4.74	24	21	M	T
Pack		94niro009	4.04	16	19	M	T
Payette R, below Payette WWTP		na	4.00	18	11	M	T
Payette R., MF@ Tie Cr camp		94SWIROA44	4.55	18	23	M	T
Payette R., MF@county line		95SWIROB09	2.62	10	19	M	T
Payette R@Black Canyon		na	3.14	12	11	M	T
Prichard		96nirob32	2.60	18	9	M	T
Rock Creek		95SCIROA59	2.88		7	M	T
Rock Creek		95SCIROA61	2.81		9	M	T
St Maries		96niroa40	4.83	24	23	M	T
St Maries, WF		96niroa46	3.91	22	21	M	T
ANTELOPE CREEK	1995SIDF0A57	95EIRO0A57	3.45	14	17	M	T
BEDROCK CREEK	1997SLEWZ03	97NCIROZ03	3.61	10	19	M	T
BIG CANYON CREEK	1997SLEWZ11	97NCIROZ11	3.31	10	17	M	T
BIG DEER CREEK (LOWER)	1995SIDF0B77	95EIRO0B77	2.68	18	13	M	T
CATHOLIC	1997SLEWZ01	97NCIROZ01	3.79	14	15	M	T

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
CREEK							
CATHOLIC CREEK	1997SLEWZ02	97NCIROZ02	3.04	18	11	M	T
CATHOLIC CREEK	1997SLEWZ04	97NCIROZ04	4.14	20	15	M	T
CLEAR CREEK (LOWER)	1996SLEWA23	96NCIROA23	4.78	20	23	M	T
CLOVER CREEK	1997STWFA033	97SCIROA33	5.00	22	21	M	T
CLOVER CREEK	1997STWFA034	97SCIROA34	3.98	18	17	M	T
CLOVER CREEK	1997STWFA042	97SCIROA42	3.17	14	13	M	T
CLOVER CREEK (LOWER)	1997STWFB016	97SCIROB16	3.76	14	11	M	T
CLOVER CREEK (MIDDLE)	1997STWFA014	97SCIROA14	2.40	10	15	M	T
CLOVER CREEK (MIDDLE)	1997STWFB014	97SCIROB14	2.31	8	13	M	T
CRANE CREEK	1996SBOIB022	96SWIROB22	2.67	6	7	M	T
EF BIG LOST RIVER	1995SIDF0A36	95EIRO0A36	1.33	10	7	M	T
LAPWAI CREEK	1996SLEWZ01	96NCIROZ01	2.70	10	13	M	T
LAPWAI CREEK	1997SLEWZ16	97NCIROZ16	4.93	10	17	M	T
LAPWAI CREEK	1997SLEWZ17	97NCIROZ17	5.45	14	19	M	T
LAWYER CREEK	1997SLEWZ21	97NCIROZ21	5.25	12	21	M	T
LITTLE CANYON CREEK	1996SLEWZ10	96NCIROZ10	3.90	14	15	M	T
LITTLE SALMON RIVER (LOWER)	1997SBOIB027	97SWIROB27	2.68	10	17	M	T
LOOP CREEK (LOWER)	1997SCDAA28	97NIRO0A28	4.03	12	19	M	T
MEDICINE LODGE CREEK (UPPER)	1994SIDF00066	94EIRO0066	4.42	12	23	M	T
MISSION CREEK	1997SLEWZ08	97NCIROZ08	5.17	20	23	M	T
MISSION CREEK	1997SLEWZ19	97NCIROZ19	5.68	18	23	M	T
MISSION CREEK	1997SLEWZ20	97NCIROZ20	4.59	10	19	M	T
PALOUSE RIVER (LOWER)	1996SLEWB44	96NCIROB44	4.03	14	21	M	T
PANTHER	1995SIDF0B78	95EIRO0B78	1.29	10	11	M	T

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
CREEK (LOWER)							
PANTHER CREEK (MIDDLE)	1995SIDFB079	95EIROB079	1.61	10	9	M	T
PRICHARD CREEK (LOWER)	1997SCDAB02	97NIRO0B02	4.48	18	15	M	T
PRICHARD CREEK (UPPER)	1997SCDAB01	97NIRO0B01	4.65	22	15	M	T
RAPID LIGHTNING CREEK	1997SCDAA13	97NIRO0A13	4.61	16	19	M	T
RED ROCK CREEK	1997SLEWZ12	97NCIROZ12	1.97	10	9	M	T
SALMON FALLS CREEK (MID)	1996STWFA040	96SCIROA40	4.09	16	17	M	T
SAND CREEK (LOWER)	1997SCDAA16	97NIRO0A16	3.81	16	15	M	T
SAND CREEK (UPPER)	1997SCDAA17	97NIRO0A17	3.21	10	17	M	T
SHERIDAN CREEK (LOWER)	1995SIDF0A64	95EIRO0A64	2.80	12	11	M	T
SHERIDAN CREEK (LOWER)	1995SIDF0A65	95EIRO0A65	3.40	12	13	M	T
SHOSHONE CREEK	1996STWFA007	96SCIROA07	4.49	12	21	M	T
SHOSHONE CREEK	1996STWFA008	96SCIROA08	3.33	18	13	M	T
ST MARIES RIVER	1997SCDAA33	97NIRO0A33	4.53	24	21	M	T
SUCCOR CREEK (LOWER)	1997SBOIA008	97SWIROA08	3.71	18	19	M	T
SUCCOR CREEK (MIDDLE)	1997SBOIA009	97SWIROA09	3.17	8	9	M	T
SWEETWATER CREEK	1997SLEWZ14	97NCIROZ14	4.77	12	23	M	T
YANKEE FORK (LOWER)	1995SIDF0A92	95EIRO0A92	5.17	18	23	M	T
Little Wood R (U)	1997RSCIROQ002		4.38	14	21	M	T
Pack R	1997RNIRO0Q003		2.30	10	15	M	T
Weiser R	ISU1996D1			13	23	M	T
Bruneau R	ISU1996D2			21	23	M	T

Water Body	Site ID	Old Site ID	MBI	IMRI	IRI	Size	R,T,O
Big Wood R - Bellvue	ISU1996D3			13	21	M	T
Blackfoot R	ISU1996D4			9	23	M	T
Portneuf R	ISU1996D5			13	23	M	T
SF CDA	1997ISU			15		M	T
Panther	1997ISU			15		M	T
Blackfoot	1997ISU			9		M	T

Appendix D.
RFI DATA

Water Body	Site ID	River Basin	R,T,O	RFI
Bear Cr	96SIDFY31	USNK	R	81
Big Lost R@Chilly93	USNK-24	USNK	R	71
Big Lost R@Chilly94	USNK-24	USNK	R	74
Big Lost R@Chilly95	USNK-24	USNK	R	71
Big Lost R+Chilly94	USNK-24-94a	USNK	R	75
Big Lost R-Chilly94	USNK-24-94c	USNK	R	76
Big Wood R nr Baker Cr (9/93)	1995STWFB049	USNK	R	79
Big Wood R nr Boulder Cr	USNK-26	USNK	R	84
Bitch Cr + Swanner Cr	1996SIDFY131	USNK	R	91
Bitch Cr near Lamont, ID	USNK-8-93	USNK	R	87
Falls River nr Squirrel	USNK-7	USNK	R	77
Grays Lake Outlet	95SIDFB69	USNK	O	56
Greys@Palisades	USNK-3	USNK	R	79
Henrys@Ashton, ID	USGS-13046000-99	USNK	R	80
Henry's@Rexburg, ID	USGS-13056500-99	USNK	T	62
Henrys@Rexburg93	USNK-10-93	USNK	T	39
Henrys@Rexburg96	USNK-10-96	USNK	T	45
Henrys@St Anthony, ID	USGS-13050500-99	USNK	R	78
Little Granite@Hoback	USNK-2-93	USNK	R	84
Little Wood@Carey	USNK-27	USNK	R	82
Malad River	USNK-28	USNK	T	18
Marsh@McCammon, ID	USGS-130075000-97	USNK	T	46
Medicine@Small93	USNK-23	USNK	R	84
Medicine@Small97	94SIDF67	USNK	R	77
Portneuf@Pocatello96a	USNK- ?-96	USNK	T	TFF
Portneuf@Pocatello96b	USNK- ?-96	USNK	T	60
Portneuf@Topaz93	USNK-12	USNK	T	19
Portneuf@Topaz94	USNK-12	USNK	T	36
Portneuf@Topaz95	USNK-12	USNK	T	36
Robinson Cr + Rock Cr	1996SIDFY055	USNK	R	75
Robinson@Warm	USNK-6	USNK	R	74
Rock@Rock93	USNK-17	USNK	T	36
Rock@US30 93	USNK-18-93	USNK	T	61
Rock@US30 94	USNK-18-94b	USNK	T	75
Rock@US30 95	USNK-18-95	USNK	T	73
Rock@US30 96	USNK-18-96	USNK	T	62
Rock@US30 97a	USNK-18-97a	USNK	T	64
Rock@US30 97b	USNK-18-97b	USNK	T	53
Rock+US30 94	USNK-18-94a	USNK	T	53
Rock-US30 94	USNK-18-94c	USNK	T	63
Salt@Etna93	USNK-5	USNK	T	77

Water Body	Site ID	River Basin	R,T,O	RFI
Salt@Etna94	USNK-5	USNK	T	76
Salt@Etna95	USNK-5	USNK	T	73
Salt@Smoot	USNK-4	USNK	R	96
Sheridan@IPR	95SIDFA64	USNK	T	40
Snake@Blackfoot93	USNK-11-93	USNK	T	46
Snake@Blackfoot96	USNK-11-96	USNK	T	60
Snake@Buhl93	USNK-19-93	USNK	T	10
Snake@Buhl96	USNK-19-96	USNK	T	9
Snake@Buhl97	USNK-19-97	USNK	T	20
Snake@Buhl99	USNK-19-99	USNK	T	29
Snake@Flagg93	USNK-1	USNK	R	73
Snake@Flagg94	USNK-1	USNK	R	82
Snake@Flagg95	USNK-1	USNK	R	81
Snake@Glenns Ferry	? Data provided by IDEQ-TWF	USNK	T	17
Snake@Heise, ID	USGS-13037500-99	USNK	R	83
Snake@Kings93	USNK-30	USNK	T	9
Snake@Kings94	USNK-30	USNK	T	32
Snake@Kings95	USNK-30	USNK	T	20
Snake@Kings96	USNK-30-96	USNK	T	27
Snake@Kings97	USNK-30-97	USNK	T	15
Snake@Kings98	USNK-30-98	USNK	T	25
Snake@Kings99	USNK-30-99	USNK	T	19
Snake@Massacre Rocks, ID	IPC1995AFB	USNK	T	58
Snake@Minidoka93	USNK-14-93	USNK	T	3
Snake@Moose	USNK-	USNK	R	84
Spring Cr@Ft Hall	USNK-13	USNK	R	74
Teton@Driggs	95SIDFA112	USNK	R	86
Teton@St Anthony	USNK-9	USNK	T	81
Warm+Robinson	97SIDFM75	USNK	R	71
Willow-GLO	94SIDF79	USNK	O	48
Bitterroot@Missoula, MT	NROK-5	PAN	R	54
Blackfoot@Helmville, MT	NROK-4	PAN	R	70
Clark Fk@Bonner, MT	NROK-3	PAN	T	35
Clark Fk@Galen, MT	NROK-1	PAN	T	79
Clark Fk@St Regis, MT	NROK-6	PAN	T	71
Clark Fork@Cabinet	WWP-94	PAN	T	44
Flathead@Perma, MT	NROK-9	PAN	T	23
Hangman Ck@ Spokane, WA	NROK-22	PAN	T	30
Lightning Ck@Clark Fk, ID	NROK-11	PAN	T	49
Mid Fk Flathead@Glacier, MT	NROK-8	PAN	R	75
N Fk Coeur d'Alene + Enaville, 6/88	NF1-Dames&Moore 89	PAN	R	90
N Fk Coeur d'Alene R + Enaville, 9/87	NF1-Dames&Moore 89	PAN	R	89
N Fk Coeur d'Alene@Enaville, ID	NROK-14	PAN	R	51
Priest@Priest R, ID	NROK-12	PAN	T	21
Rock Ck@Clinton, MT	NROK-2	PAN	R	69

Water Body	Site ID	River Basin	R,T,O	RFI
0	0	Name?	0	Basin?
S Fk Coeur d’ Alene nr Mullan	NROK98	PAN	R	81
S Fk Coeur d’Alene - Big Cr 6/88	SF2-Dames&Moore 89	PAN	T	64
S Fk Coeur d’Alene - Big Cr 9/87	SF2-Dames&Moore 89	PAN	T	20
S Fk Coeur d’Alene@Kellogg 6/88	SF4-Dames&Moore 89	PAN	T	TFF
S Fk Coeur d’Alene@Kellogg 9/87	SF4-Dames&Moore 89	PAN	T	29
S Fk Coeur d’Alene@Pinehurst, ID	NROK16	PAN	T	39
S Fk Coeur d’Alene@Pinehurst, ID	NROK-16-1999A	PAN	T	65
S Fk Coeur d’Alene@Pinehurst, ID	NROK-16-1999B	PAN	T	58
S Fk Coeur d’Alene@Pinehurst, ID	NROK-16-1999C	PAN	T	50
S Fk Coeur d’Alene@Pinehurst, ID 6/88	SF8-Dames&Moore 89	PAN	T	41
S Fk Coeur d’Alene@Pinehurst, ID 9/87	SF8-Dames&Moore 89	PAN	T	TFF
S Fk Coeur d’Alene@Smelterville 6/88	SF5-Dames&Moore 89	PAN	T	TFF
S Fk Coeur d’Alene@Smelterville 9/87	SF5-Dames&Moore 89	PAN	T	26
Spokane R. @ Green St, WA	USGS 12420800	PAN	T	25
Spokane R. @ Sullivan Bridge,WA	USGS 12420800	PAN	T	45
Spokane R. + Liberty Bridge,WA	USGS 12420800	PAN	T	28
Spokane R.@ Post Falls, ID	NROK-20-1999	PAN	T	1
Spokane R.+ 7-mile bridge, WA	USGS 12424500	PAN	T	54
Spokane R@ Spokane, WA	NROK-21	PAN	T	16
Spokane R@Post Falls, ID	NROK-20	PAN	T	25
St Joe@ Calder, ID	NROK-19	PAN	R	51
St Joe@ Red Ives Ranger Station	NROK-18-1999A	PAN	R	96
St Joe@ Red Ives Ranger Station	NROK-18-1999B	PAN	R	100
St Joe@ Red Ives Ranger Station	NROK-18-1999C	PAN	R	100
St Joe@ Red Ives, ID	NROK-18	PAN	R	99
Big Smokey Cr	95SCIROA75	LSNK	R	TFF
Boise (Caldwell)	WRIR99-4178-5-AUG97	LSNK	T	23
Boise (Glenwood Br)	WRIR99-4178-3-DEC96	LSNK	T	52
Boise (Glenwood Br)	WRIR99-4178-3-FEB95	LSNK	T	46
Boise (Loggers Cr Div)	WRIR99-4178-2-DEC96	LSNK	T	90
Boise (Middleton)	WRIR99-4178-4-AUG97	LSNK	T	27
Boise (Middleton)	WRIR99-4178-4-DEC96	LSNK	T	39
Boise (Parma 96)	WRIR99-4178-6-DEC96	LSNK	T	11
Boise (Parma 97)	WRIR99-4178-6-AUG97	LSNK	T	7

Water Body	Site ID	River Basin	R,T,O	RFI
Boise R - Lander St WWTF	WRIR98-4123-2-DEC96	LSNK	T	57
Boise R - Lander St WWTF	WRIR98-4123-2-MAR95	LSNK	T	48
Boise R - W Boise WWTF	WRIR98-4123-4-DEC96	LSNK	T	60
Boise R - W Boise WWTF	WRIR98-4123-4-MAR95	LSNK	T	66
Boise R + Lander St WWTF	WRIR98-4123-1-DEC96	LSNK	T	78
Boise R + Lander St WWTF	WRIR98-4123-1-MAR95	LSNK	T	92
Boise R + W Boise WWTF	WRIR98-4123-3-DEC96	LSNK	T	65
Boise R + W Boise WWTF	WRIR98-4123-3-MAR95	LSNK	T	62
Bruneau R. - Hot Creek, ID	1997STWFA035	LSNK	R	TFF
Jarbidge River - EF Jarbidge	1997SCIROA032	LSNK	R	92
Malheur R, OR	EMAP ORST97-073	LSNK	T	31
Malheur R, OR	EMAP ORST97-070	LSNK	T	36
Marsh Cr + MF Salmon R conf.	1997SIDFM147	LSNK	R	TFF
McCoy Cr, OR	EMAP ORST97-153	LSNK	T	85
NF Burnt R, OR	EMAP ORST97-135	LSNK	T	73
North Powder River, OR	EMAP ORST97-113	LSNK	T	54
Payette (Black Canyon)	RM36-97 (IDFG)	LSNK	T	60
Payette (Blacks Br)	RM15-97 (IDFG)	LSNK	T	43
Payette (County line)	RM18-97 (IDFG)	LSNK	T	23
Payette (Fruitland)	RM4-97 (IDFG)	LSNK	T	24
Payette (Hwy 52 Br)	RM33-97 (IDFG)	LSNK	T	52
Payette (Letha Br)	RM25-97 (IDFG)	LSNK	T	32
Payette (mouth)	RM1-97 (IDFG)	LSNK	T	14
Payette (Smiths)	RM30-97 (IDFG)	LSNK	T	40
Salmon Falls Cr(8/96)	96SCIROA40	LSNK	R	25
Salmon Falls Cr(TF1)	? Data provided by IDEQ-TWF	LSNK	O	59
Salmon Falls Cr(TF2)	? Data provided by IDEQ-TWF	LSNK	O	56
Salmon Falls Cr@Bal.Rock	96SCIROA06	LSNK	R	TFF
Salmon R @ Whitebird	USGS 13317000	LSNK	R	51
Salmon R - Partridge Cr, nr Riggins, ID	1999RLEW001 (USGS 13315000)	LSNK	R	82
Salmon R - Yankee Fork nr Clayton, ID	1999RIDF001 (USGS 13296500)	LSNK	R	95
Salmon R + NF Salmon nr N Fork, ID	1999RIDF003 (USGS 13298500)	LSNK	R	84
Salmon R + Pahsimeroi R nr Challis, ID	1999RIDF002 (USGS 13298500)	LSNK	R	93

Water Body	Site ID	River Basin	R,T,O	RFI
Salmon R nr Obsidian (1)	1998SIDFC057	LSNK	R	TFF
Salmon R nr Obsidian (2)	19995SIDFA76	LSNK	R	87
SalmonFalls Cr@Lily	USNK-22	LSNK	R	83
SF Boise	IDFG 8/94	LSNK	R	98
Snake - Lower Salmon Falls dam	IPC1995AJW	LSNK	T	31
Snake - Swan Falls dam	IPC1995SFB	LSNK	T	20
Snake@Nyssa, OR	USGS 97-13213100	LSNK	T	8
Squaw Cr nr Clayton, ID	Chadwick80-SQ2	LSNK	R	100
Squaw Cr nr Clayton, ID	Chadwick81-SQ2	LSNK	R	100
Squaw Cr nr Clayton, ID	Chadwick82-SQ2	LSNK	R	100
Squaw Cr nr Clayton, ID	Chadwick86-SQ2	LSNK	R	89
Squaw Cr nr Clayton, ID	Chadwick89-SQ2	LSNK	R	98
Squaw Cr nr Clayton, ID	Chadwick90-SQ2	LSNK	R	98
Squaw Cr nr Clayton, ID	Chadwick91-SQ2	LSNK	R	94
Squaw Cr nr Clayton, ID	Chadwick96-SQ2	LSNK	R	100
Squaw Cr nr Clayton, ID	Chadwick97-SQ3	LSNK	R	98
Squaw Cr nr Clayton, ID	Chadwick98-SQ2	LSNK	R	94
Squaw Cr nr Clayton, ID	Chadwick99-SQ2	LSNK	R	99
Valley Cr nr Stanley, ID	1995SIDFA073	LSNK	R	92
Wallowa R, OR	EMAP ORST97-179	LSNK	R	85
Wenaha R, OR	EMAP ORST97-194	LSNK	R	91
Yankee Fork Salmon(L)	95SIDFA93	LSNK	T	TFF
Yankee Fork Salmon(U)	95SIDFA92	LSNK	R	91
Sprague R. OR	EMAP ORST97-215	KLAM	O	25
Sprague R. OR	EMAP ORST97-216	KLAM	O	38
Bear R. - Smiths Fork, WY	USGS 10038000	GBAS	O	40
Bear R. nr Corrine, UT	USGS 1012600	GBAS	O	6
Bear R. nr Montpelier, ID	USGS 10068500	GBAS	O	22
Donner and Blitzen R, OR	EMAP ORST97-333	KLAM	O	93
American River nr Nile, WA	USGS YAKI-5	COL	R	86
Big Marsh,OR	EMAP ORST97-311	COL	T	62
Clatskanie R,OR	EMAP ORST97-004	COL	O	62
Deschutes R, OR	EMAP ORRV98-027	COL	R	80
Deschutes R, OR	EMAP ORRV98-029A	COL	R	86
Deschutes R, OR	EMAP ORRV98-029B	COL	R	75
Hood R, OR	EMAP ORST97-020	COL	R	98
John Day R,OR	EMAP ORRV98-067	COL	R	13
John Day R,OR	EMAP ORST97-028	COL	R	19
MF Willamette R, OR	EMAP ORRV98-133A	COL	O	77
MF Willamette R, OR	EMAP ORRV98-133B	COL	O	85
MF Willamette R, OR	EMAP ORRV98-135	COL	O	89
MF Willamette R, OR	EMAP ORST97-313	COL	O	80
Mill Cr, OR	EMAP ORST97-046	COL	R	78
NF John Day R, OR	EMAP ORRV98-073	COL	R	33
NF John Day R, OR	EMAP ORST97-176	COL	R	55
NF MF Willamettee	EMAP ORST97-308	COL	O	81
South Santiam R, OR	EMAP ORRV98-179A	COL	O	83

Water Body	**Site ID**	**River Basin**	**R,T,O**	**RFI**
Willamette R, OR	EMAP ORRV98-181	COL	O	32
Willow Cr,OR	EMAP ORST97-058	COL	T	45
Yakima R - Toppenish Cr, WA	USGS YAKI-26	COL	T	31
Yakima R + Umtanum Cr, WA	USGS YAKI-22	COL	R	54
Yakima R at Cle Elum, WA	USGS YAKI-21	COL	R	87
Yakima R at Kiona, WA	USGS YAKI-28	COL	T	19
Yakima R at Parker, WA	USGS YAKI-25	COL	T	21
Nehahem R, OR	EMAP ORRV98-003	COAST	O	83
Rogue R, OR	EMAP ORRV98-091A	COAST	O	81
Rogue R, OR	EMAP ORRV98-091B	COAST	O	86
Umpqua R, OR	EMAP ORRV98-161	COAST	O	20
Alsea R	EMAP ORRV98-191-10	COL	O	74
Alsea R	EMAP ORRV98-191-9	COL	O	59
Siletz R.	EMAP ORST97-429	COL	O	61
Palouse R., at Hooper, WA	USGS PAL018	COL	T	22
SF Palouse R. at Colfax, WA	USGS SFP002 9/27/93	COL	T	33
SF Palouse R. at Colfax, WA	USGS SFP002 8/31/94	COL	T	29
SF Palouse R. at Colfax, WA	USGS SFP002 9/01/94	COL	T	34

Appendix E.
RDI DATA

Site Name	Site ID	Date	RDI
bgwdl	97RSCIROQ004	10/28/1997	18
bgwdu	97RSCIROQ005	10/29/1997	16
blkft	1998RPOCP001	10/5/1998	16
br1	1998RPOCP002	10/6/1998	14
br2	1998RPOCP003	10/6/1998	22
br4	1998RPOCP005	10/7/1998	10
brn51	1998RTWFP003	10/15/1998	26
brnhs	1998RTWFP002	10/14/1998	30
brnm	1998RTWFP005	10/21/1998	36
brnu	1998RTWFP004	10/21/1998	36
jrb	1998RTWFP001	10/13/1998	36
lwdu	97RSCIROQ002	10/24/1997	38
pyt	1998RBOIP006	10/27/1998	8
sfowy	1998RBOIP005	10/20/1998	28
snk	1998RBOIP004	8/27/1998	10
snkmlnr	97RSCIROQ003	10/27/1997	16
snkmsscr	97RSCIROQ001	10/23/1997	20
wsr	1998RBOIP001	8/18/1998	12
blkftl	97RSEIROQ006	10/16/1997	20
blkftu	97RSEIROQ005	10/15/1997	26
flls	97REIRO0Q001	10/7/1997	38
hnrfkl	97REIRO0Q004	10/9/1997	28
hnrfku	97REIRO0Q003	10/8/1997	30
pnflm	97RSEIROQ004	10/15/1997	16
pnfu	97RSEIROQ001	10/14/1997	30
tetnu97	97REIRO0Q002	10/8/1997	40
cdacat	1998RCDAP010	9/21/1998	32
cdahr	97RNIRO0Q005	9/29/1997	26
cdai90	1998RCDAP009	9/21/1998	28
cdarsbr	1998RCDAP011	9/22/1998	28
cdarslk	97RNIRO0Q006	9/29/1997	34
clkfk	1998RCDAP006	9/19/1998	18
efsfslm	97RSWIROQ005	9/10/1997	34
lchs	97RNCIROQ004	9/18/1997	36
lslml	1998RLEWP001	8/19/1998	16
mfbs	97RSWIROQ001	9/4/1997	38
myi	1998RCDAP005	9/18/1998	34

Site Name	Site ID	Date	RDI
nfbs	97RSWIROQ002	9/5/1997	38
nfcda	97RNIRO0Q001	9/24/1997	38
prst	1998RCDAP007	9/20/1998	24
sfbs	97RSWIROQ003	9/8/1997	32
sfcda	1998RCDAP004	9/17/1998	22
sfclwtrl	97RNCIROQ001	9/16/1997	32
sfclwtrm	97RNCIROQ002	9/16/1997	30
sfclwtru	97RNCIROQ003	9/17/1997	24
sfpyt	1998RBOIP003	8/25/1998	40
sfslm	97RSWIROQ004	9/10/1997	24
slmlcly	1998RIDFP002	9/10/1998	22
slmm	1998RIDFP005	10/1/1998	30
tetn33	1998RIDFP004	9/29/1998	34
tetu98	1998RIDFP003	9/29/1998	30
clwtr			
snkastn			
snkgrnd			
spkblby			
spkblst			
spkcp			

Appendix F.
OREGON WATER QUALITY INDEX: REVISION AND APPLICATION (Draft 1998)

Curtis. G. Cude[17]

For more information on current document, see: Cude C.G. in press. Oregon Water Quality Index: A tool for evaluating water quality management effectiveness. Journal of American Water Resource Association. Paper # 99051

ABSTRACT

The Oregon Water Quality Index (OWQI) is a single number that expresses water quality by integrating measurements of eight water quality variables (temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia+nitrate nitrogen, total phosphorus, total solids, and fecal coliform). Its purpose is to provide a simple and concise method for expressing ambient water quality. The index relies on data generated from routine ambient monitoring and can be used to analyze trends in water quality over long time periods. Oregon's ambient water quality monitoring network, maintained by the Oregon Department of Environmental Quality (DEQ) Laboratory, is designed to measure cumulative impacts from point and non-point sources of pollution in a variety of conditions. In order to maintain a manageable, yet representative, index, the OWQI has certain limitations. The OWQI is designed to aid in the assessment of general water quality and cannot determine the quality of water for specific uses. The index provides a summary of water quality data and cannot be used to provide definitive information about water quality without considering all appropriate chemical, biological, and physical data. Also, the OWQI cannot evaluate all health hazards. However, the OWQI can be used to show water quality variation both spatially and temporally. The index allows users to easily interpret data and relate overall water quality variation to variations in specific categories of impairment. The OWQI can also identify problem areas and trends in general water quality. These can be screened out and evaluated in greater detail by direct observation of pertinent data. Used in this manner, the OWQI provides a basis to evaluate effectiveness of water quality management programs and assist in establishing priorities for management purposes.

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INTRODUCTION

Raw water quality data can be misleading and confusing for the general public. It may be difficult for a person interested in water quality to interpret multiple sources of data and draw valid conclusions on overall water quality conditions and trends. This may lead to faulty assessments of water quality status and management practices. It can also be difficult to effectively communicate the results from water quality management programs. As a solution, a water quality index integrates complex data and generates a single number reflecting the overall status of general water quality in a given water body. This can ultimately increase awareness of water quality conditions and improve communication of water quality issues.

Water quality indices were first seriously proposed and demonstrated beginning in the 1970s, but were not widely utilized or accepted by agencies that monitor water quality. Oregon DEQ developed the original Oregon Water Quality Index (OWQI) in 1979 (Dunnette, 1979; Dunnette, 1980). Use of the index by Oregon DEQ was discontinued because calculations in the pre-personal computer era were too labor intensive. In 1980, the US Environmental Protection Agency (EPA) Region 10 developed complex water quality indices for each state in its region (Peterson, 1980). Oregon's EPA index contained over ninety variables, which were used in various combinations depending on hydrology and beneficial use protection. These indices were used in EPA's Environmental Management Reports until 1990, when the reports were phased out.

INDEX DEVELOPMENT

While water quality indices appear in the literature as early as 1965 (Horton, 1965), the science of water quality index development did not mature until the 1970's. Detailed discussion of environmental index theory and development is available (Ott, 1978b), as is a review of water quality indices contemporary to the original OWQI (Ott, 1978a). More recent water quality indices, including the present OWQI, are based on these earlier works.

Most water quality indices are calculated in two steps. The raw analytical results for each water quality variable, having different units of measurement, are first transformed into unitless subindex values. These subindices are then combined, or aggregated, to give a single, unitless water quality index value. Typically, aggregation is accomplished using a type of averaging function. The original OWQI was modeled after the National Sanitation Foundation's (NSF) Water Quality Index (WQI); (McClelland, 1974). In both indices, variables were chosen using the Delphi method (Dalkey, 1968), which generates results from the convergence of experts' opinions. Both indices used logarithmic transforms to convert variable results into subindex values. Logarithmic transforms take advantage of the fact that a change in magnitude at lower levels of impairment has a greater impact than an equal change in magnitude at higher levels of impairment. For aggregation, the original OWQI used a weighted arithmetic mean function (Eqn. 1) while the NSF WQI used a weighted geometric mean function (Eqn. 2). The NSF found the geometric mean function to be more sensitive to changes in individual variables.

(Eqn. 1) $WQI = \sum_{i=1}^{n} SI_i W_i$ Weighted Arithmetic Mean Function

and

(Eqn. 2) $WQI = \prod_{i=1}^{n} SI_i^{W_i}$ Weighted Geometric Mean Function

Where:
WQI is Water Quality Index result
SI_i is Subindex i
W_i is Weight given to Subindex i.

The original OWQI was discontinued in 1983 due to the excessive resources required to manually calculate index results. Improvements in computer hardware/software availability and sophistication, coupled with a desire for accessible, easily understood water quality information, renewed interest in the re-examination of the index. Gains in the understanding of the physical, chemical, and biological aspects of water quality had been made since 1979. A literature review of water quality indices developed since the introduction of the original OWQI revealed fresh approaches and new tools for index development (Dinius, 1978; Stoner, 1978; Yu and Fogel, 1978; Joung et al., 1979; Bhargava, 1983; Smith, 1987; Kung et al., 1992; Dojlido et al., 1994). Information from those sources was used to revise the OWQI.

Variable Selection and Transformation

The original OWQI included six variables: dissolved oxygen saturation, biochemical oxygen demand, pH, total solids, ammonia+nitrate nitrogen, and fecal coliform. These variables were chosen from a larger set of water quality variables compiled from water quality indices in contemporary literature. A panel of water quality experts was surveyed to determine statistical importance ratings (weighting factors) for each variable. The final six variables and their weighting factors were chosen based upon their significance to Oregon’s streams (Dunnette, 1980).

In the original OWQI, subindex values were obtained from transform tables. These original subindices served as the framework for the development of the present index. Subindex transformation formulae for the present OWQI were derived from these tables. In addition, two variables, temperature and total phosphorus, were added to the present OWQI based on increased significance of those variables to water quality in Oregon. The subsaturation portion of the dissolved oxygen (saturation) subindex was replaced with a dissolved oxygen concentration transformation, while the supersaturation portion was modified to include higher levels of supersaturated oxygen found in Oregon’s streams. Other subindices were slightly modified to provide consistency throughout the index. Lists of subindex transformation formulae are provided in Addendums 1 and 2.

The temperature subindex (Figure F-1) was specifically designed to be protective of cold water fisheries. The equation used to derive the subindex is a modified version of the EPA Region X temperature subindex (Peterson, 1980) for Oregon's cold water fisheries. The subindex reflects temperature effects on various life stages of chinook salmon, bull trout, and tailed frog (Oregon DEQ, 1994a).

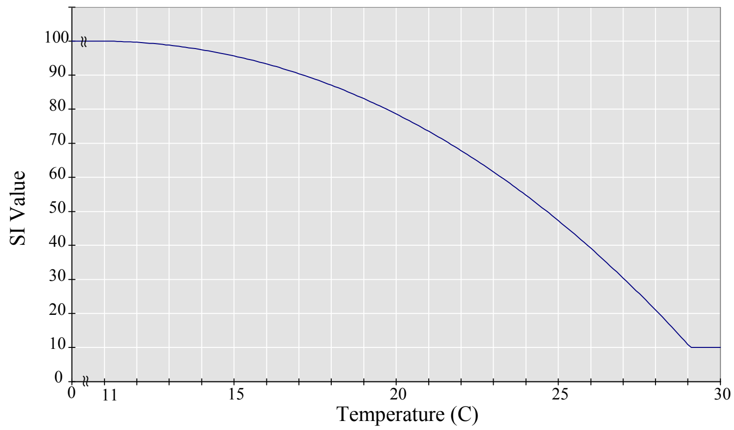

Figure F-1. Temperature Subindex (SI_T)

The original OWQI calculated dissolved oxygen (DO) subindex values based only on saturation. Evaluation of DO only in terms of saturation may result in inadequate protection at high temperatures and greater than necessary protection at low temperatures. The present OWQI uses both dissolved oxygen concentration (mg/L) and supersaturation. It is designed to meet specific DO concentration requirements for spawning, rearing, and passage, mainly of salmonids. It also addresses the concerns of gas bubble trauma, swim bladder overinflation, and respiratory distress caused by high total dissolved gas concentration. DEQ Laboratory measures DO supersaturation, a component of total dissolved gas. The DO subindices were developed as qualitative damage functions derived from impacts noted in literature (Oregon DEQ, 1994b and Baumgartner, personal communication). If DO saturation is less than 100%, subindex calculation is based on concentration (Figure F-2). If DO saturation is greater than 100%, the DO subindex calculation is based on supersaturation (Figure F-3).

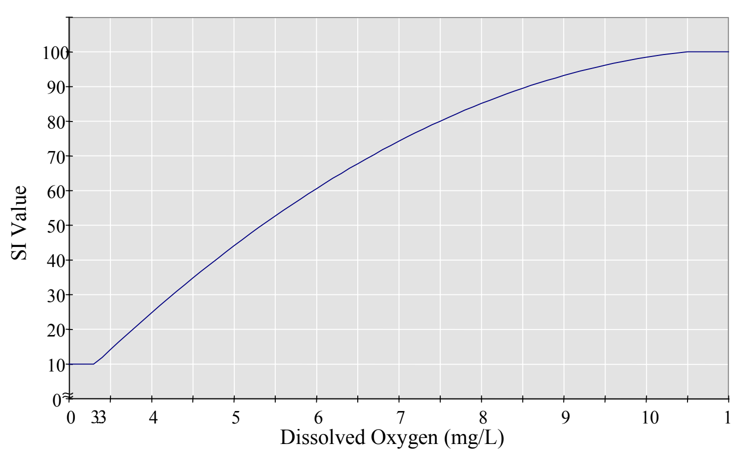

Figure F-2. Dissolved Oxygen Concentration Subindex (SI_{DOc})

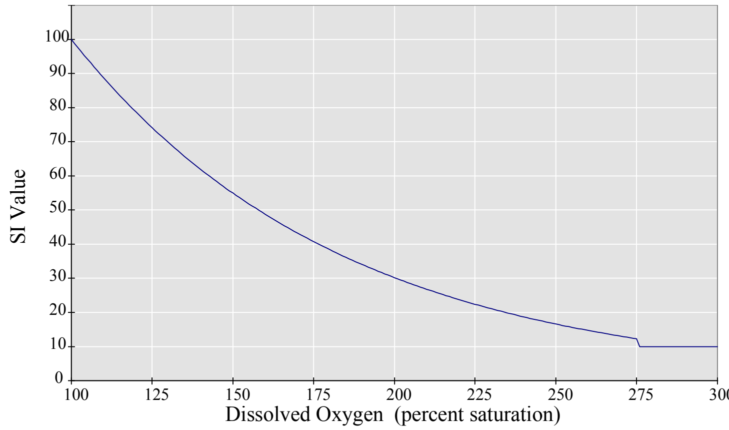

Figure F-3. Dissolved Oxygen Supersaturation Subindex (SI_{DOs})

Biochemical oxygen demand (BOD) represents the oxygen demanding capacity of organic material in a water body. BOD is widely measured by the Oregon DEQ Laboratory and is not as dependent on site-specific conditions as other measures of oxygen demand. The BOD subindex (Figure F-4) was developed for the original OWQI from expert opinions on acceptable waste loads. The present BOD subindex transforms higher BOD concentrations than did the original BOD subindex in order to characterize higher levels of BOD found in Oregon's streams.

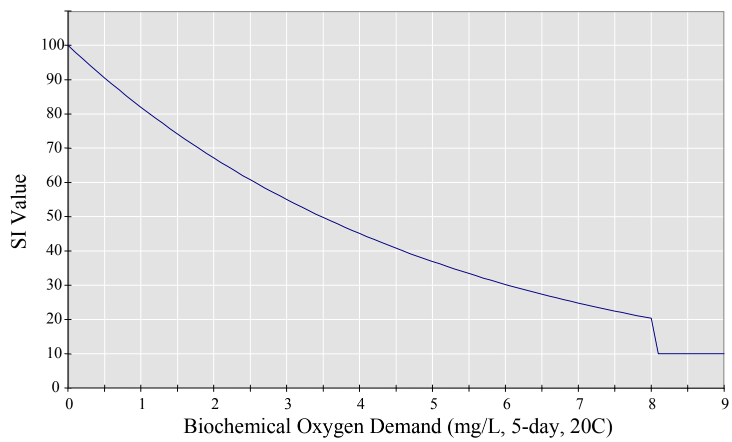

Figure F-4. Biochemical Oxygen Demand Subindex (SI_{BOD})

The pH subindex included in the original OWQI was based on the mean pH value in the Willamette River (Dunnette, 1980). While that subindex adequately characterized variation in pH in the Willamette and Coastal basins, it was not necessarily representative of other basins. Geological formations in the southern and eastern basins of Oregon tend to be more alkaline. As a result, pH of surface waters tends to be naturally higher. The pH subindex for the present OWQI (Figure F-5) is designed to protect aquatic life (Oregon DEQ, 1994c), while recognizing natural geological differences between basins. To account for geological variability, a pH subindex value of 100 was assigned to all waters having pH between and including 7.0 and 8.0 Standard Units.

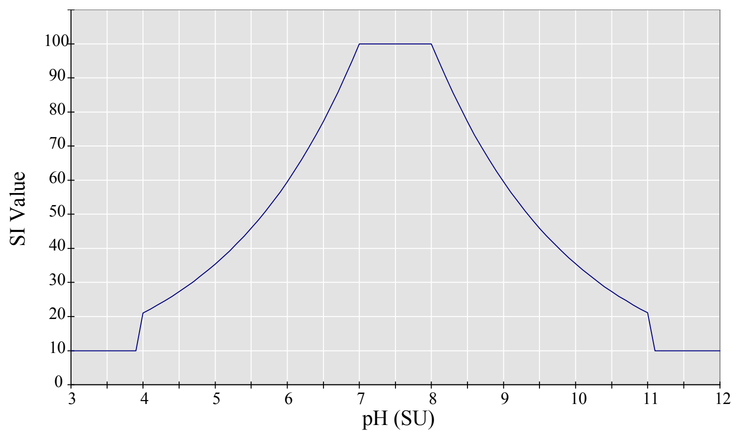

Figure F-5. pH Subindex (SI_{pH})

The nutrients subindices (ammonia+nitrate nitrogen and total phosphorus) were designed to address the potential for eutrophication. An increase in the availability of nitrogen and phosphorus increases the potential for algal growth. Excessive algal growth and the subsequent large diurnal variations in pH and DO, corresponding to the algal respiration cycle, can severely impact fish and other aquatic life. For the nitrogen subindex (Figure F-6), ammonia and nitrate concentrations are summed prior to calculating the subindex value. Ammonia nitrogen was included in the subindex because ammonia is highly toxic to aquatic fauna and nitrogenous oxygen demand is a significant impact to some of Oregon's waterbodies (Dunnette, 1980).

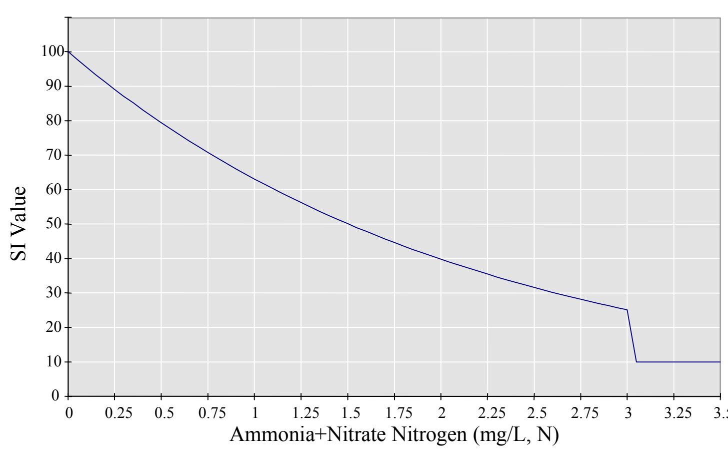

Figure F-6. Ammonia+Nitrate Nitrogen Subindex (SI_N)

Phosphorus was not included in the original OWQI, as insufficient information was available on the significance of phosphorus in Oregon waters at that time (Dunnette, 1980). Phosphorus is now recognized as a limiting nutrient for most nuisance algal growth. Dissolved orthophosphate (PO_4^{-3}) provides an indication of readily available phosphorus. However, considerable quantities of phosphorus can be bound to fine and coarse particulate material traveling in the water column. Thus, total phosphorus provides a measure of the potential pool of this nutrient. The total phosphorus subindex (Figure F-7) is based upon field experience of risk of eutrophication in Oregon's waters (Baumgartner, personal communication).

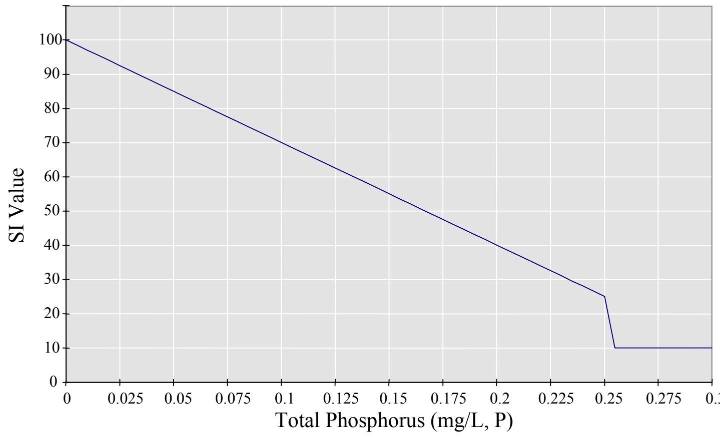

Figure F-7. Total Phosphorus Subindex (SI_P)

The total solids subindices were designed to account for geological variability of Oregon's basins. Geologically similar basins were grouped together and transformation equations were developed to distinguish background conditions (mainly dissolved solids) from erosional processes (mainly suspended solids). Eight separate total solids subindices were developed for the original OWQI. Modifications were made to some of these subindices to better reflect available geological information. Figure F-8 presents one of the total solids subindices. Most of the water quality data from ambient monitoring sites in the Powder, Malheur, and Owyhee Basins between 1986 and 1996 were collected by the US Bureau of Reclamation (USBR). As the USBR did not analyze for total solids, it was necessary to derive total solids concentrations using the following relationship:

(Eqn. 3) Total solids (mg/L) = $f * \chi$ (Dojlido and Best, 1993),
where f = 0.55-0.9, determined experimentally on the particular water,
and χ = specific conductivity in µS/cm.

Using all historic DEQ data (including total solids and specific conductivity analyses) for the Powder, Malheur, and Owyhee Basins, f was empirically determined to be 0.78.

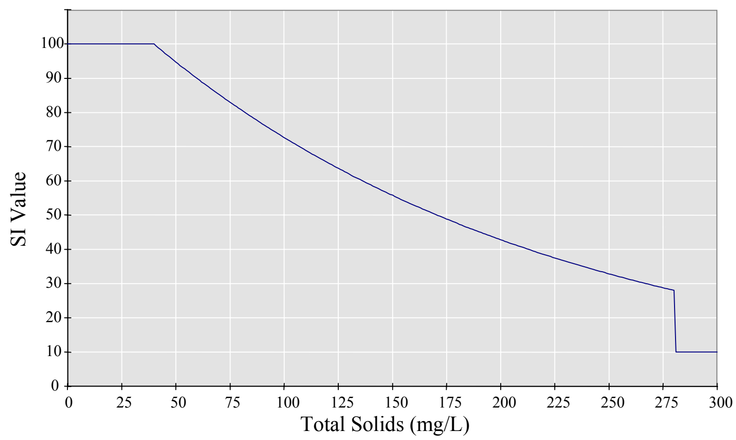

Figure F-8. Total Solids Subindex (SI_{TS}). Willamette, Sandy, and Hood Basins

Fecal coliform serves as an indication of possible microbial contamination of water because direct search for a specific pathogen is too costly and impractical for routine monitoring purposes. The fecal coliform subindex (Figure F-9) was designed to indicate potentially dangerous microbial contamination. Fecal coliform counts of less than 50 per 100 mL are assigned a subindex value of 98. This is due to the uncertainty of analytical procedures for counting bacteria.

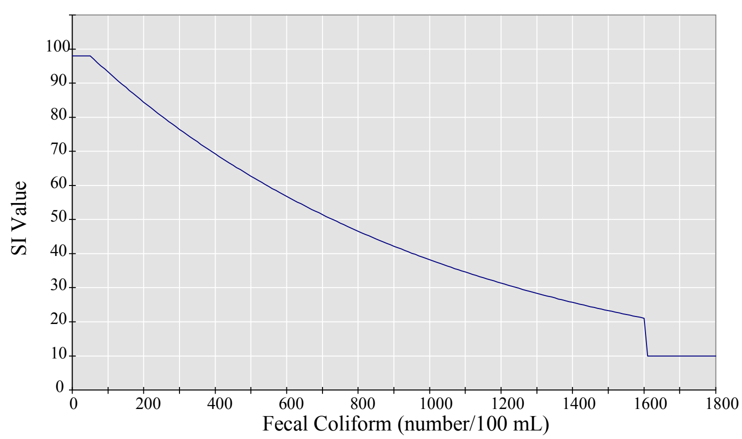

Figure F-9. Fecal Coliform Subindex (SI_{FC})

Aggregation and Calculation of OWQI

To determine the sensitivity of various aggregation methods to changes in various water quality variables, the unweighted harmonic square mean formula (Eqn. 4 and Addendum 3), the weighted arithmetic mean formula from the original OWQI (Eqn. 1), and the weighted geometric mean formula of the NSF WQI (Eqn. 2) were compared using real and idealized sets of water quality data. For the idealized data sets, each subindex value was varied from 100 (ideal) to 10 (worst case) while the other subindex values were set at a value of 100. In all trials, the unweighted harmonic square mean formula was most sensitive to changes in single variables. This formula (Dojlido et al., 1994) allows the most impacted variable to impart the greatest influence on the water quality index. This method acknowledges that different water quality variables will pose differing significance to overall water quality at different times and locations. In methods that assign fixed weights to variables, the variable given the greatest statistical weight has the greatest influence on water quality index scores. For instance, in an index heavily weighted towards DO, high concentrations of fecal coliform may not be reflected in index results if DO concentration is near ideal. This characteristic may be desirable in water quality indices specific to the protection of aquatic life. However, the OWQI is designed to communicate general water quality rather than the quality of water for any specific use. For this general type of water quality index, sensitivity to changes in each variable is more desirable than sensitivity to the most heavily weighted variable.

(Eqn. 4)

$$WQI = \sqrt{\frac{n}{\sum_{i=1}^{n} \frac{1}{SI_i^2}}}$$

Unweighted Harmonic Square Mean Function

Where:
WQI is Water Quality Index result
n is the number of subindices
SI_i is Subindex i.

Classification of OWQI Scores

To develop a classification scheme and descriptive labels for the OWQI, a distribution curve was generated from OWQI scores calculated from data collected at 136 monitoring sites located throughout Oregon from water years 1986 through 1995. Streams with severe water quality impacts often receive more attention with respect to increased ambient monitoring and intensive surveys. To normalize the data from each monitoring site for variability in sampling frequency, water quality data for each site was thinned to a maximum of one sample per quarter. Mean values from the normalized data set were calculated for each monitoring site. The OWQI classification scheme was derived from the distribution of the normalized mean OWQI scores for each monitoring site. OWQI scores that are less than 60 are considered very poor; 60-79 poor; 80-84 fair; 85-89 good; and 90-100 excellent.

APPLICATIONS

Spatial Comparison

The OWQI is designed to permit spatial comparison of water quality among different reaches of a river or between different watersheds. This is accomplished, in part, because the pH and total solids functions within the index account for geological variability. Also, the OWQI aggregation formula accounts for the variability of factors limiting water quality in different watersheds. In order to account for differences in water quality between low flow summer months (June - September) and higher flow fall, winter, and spring (October - May), seasonal average values are calculated and compared. Mean is used as the measure of central tendency, because the distribution of means for all monitoring sites more closely resembles a normal distribution than does the distribution of medians. The distribution of medians is bimodal and more left-skewed than the distribution of means. Ambient water quality monitoring sites are ranked based on the minimum of the seasonal averages (Cude, 1997). For each site, the data are analyzed to determine which variables influence general water quality during various seasons.

Figure F-10 presents the spatial distribution of minimum seasonal average OWQI scores for ambient water quality monitoring sites on the Tualatin River. Water quality in the Tualatin Subbasin is influenced by logging operations, intensive agricultural and container nursery operations, confined animal feeding operations (CAFOs), industrial operations, municipal sewage treatment plants, urban nonpoint source pollution, and natural hydrological conditions. Because of the low gradient of the primary streams in the subbasin, water flows slowly. Point and nonpoint source pollution is slowly moved downstream and is not readily assimilated. Two advanced tertiary wastewater treatment plants (AWWTP) are located on the Tualatin River: Rock Creek AWWTP at river mile 38.0 and Durham AWWTP at river mile 9.6. Two smaller municipal point sources are located on the Tualatin River above Rood Bridge. Loading from the major point sources is reflected in the OWQI scores of the two downstream sites (HWY 210 and Boones Ferry Road). Inspection of the individual subindices for the monitoring stations reveals very high concentrations of ammonia and nitrate nitrogen and total phosphorus. High concentrations of fecal coliform, total solids, and biochemical oxygen demand also impact water quality. This indicates the presence of organic matter and sediments in the water. Low dissolved oxygen concentrations were seen in conjunction with high concentrations of ammonia nitrogen at all sites except the most upstream site, indicating that ammonia was scavenging oxygen for conversion to nitrate nitrogen. These individual impacts were greater at the monitoring sites downstream of the AWWTPs. Average OWQI scores range from poor to very poor, generally decreasing from upstream to downstream. The poor average OWQI score at the most upstream site indicates that non-point source pollution, with some contribution from point sources, limits water quality in the Tualatin Subbasin. Specific information pertaining to individual monitoring sites in the Tualatin Subbasin is available (Cude, 1996).

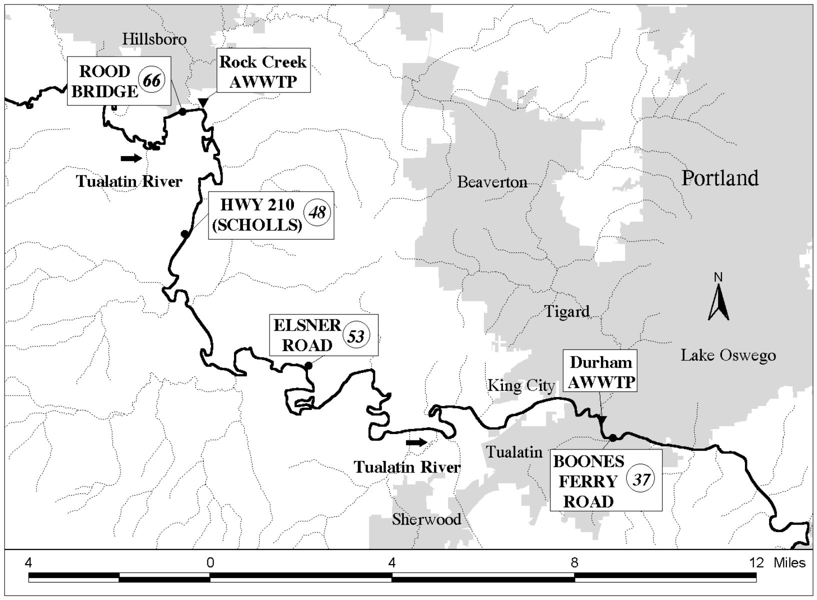

Figure F-10. Minimum Seasonal Average OWQI Results for the Tualatin River (WY 1986-1995)

Trend Analysis

For long-term trend analysis, ten water years of ambient water quality monitoring data were analyzed for each monitoring site. This time period attenuates the effects of drought cycles and ensures that sufficient data are available to analyze for trends. The nonparametric Seasonal-Kendall trend analysis (Hirsch et al., 1982) is appropriate for trending OWQI scores since the test assumes neither normal distribution nor independence (OWQI scores derived from ambient water quality data are serially correlated). This test can also analyze for trends in data sets with missing values. For each site with sufficient data, the Seasonal-Kendall test divides the data set into twelve subsets, one for each month. Each of these subsets is analyzed for the direction, magnitude, and significance of trends. These subsets are compared and an annualized result is generated, indicating whether or not a significant trend exists. This procedure ensures that increasing or decreasing trends are consistent through most of the year and that the trends are not due to normal seasonal variation.

Figure F-11 displays application of the Seasonal-Kendall trend analysis to OWQI scores for the Tualatin River at Oregon Highway 210 in Scholls, Oregon. Starting in mid-1989, the Unified Sewerage Agency (Washington County, Oregon) began to take steps to improve treatment of wastewater treatment plant effluents, per the Total Maximum Daily Load allocations established by the Oregon Department of Environmental Quality (State of Oregon, 1988; Oregon DEQ, 1988a; Oregon DEQ, 1988b). The Rock Creek AWWTP began conversion of effluent ammonia nitrogen to nitrate nitrogen in August 1989. The new process should have no net effect on ammonia and nitrate nitrogen subindex scores because nitrate nitrogen concentration increased as ammonia nitrogen concentration decreased.

However, the new process did reduce nitrogen-related biochemical oxygen demand, so BOD and DO subindex scores should improve over time. The Rock Creek AWWTP began removal of phosphorous in August 1990. Due to the advanced treatment of nutrients in effluent, total solids concentrations increased. A basin-wide phosphate detergent ban was instituted in February 1991. This ban had no direct impact on WWTP effluent as phosphates were already eliminated from the effluent, but it did decrease the cost of treatment of influent. However, the ban helped to decrease non-point source pollution from phosphate-based detergents entering streams via storm drains and faulty septic systems. A Seasonal-Kendall trend analysis show that OWQI values increased 34 points over ten years. The improvement seen at this site was the greatest improvement seen of all DEQ Laboratory-monitored sites in the state.

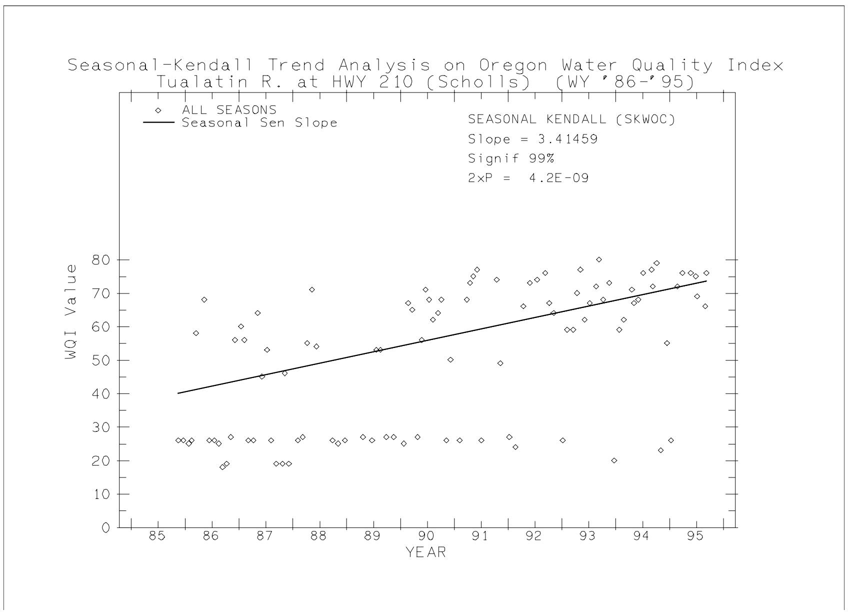

Figure F-11. Trend Analysis Results for Tualatin River at HWY 210 (Scholls)

Seasonal Wilcoxon-Mann-Whitney step trend analyses (Crawford, et al., 1983) were performed on raw data, subindex values, and OWQI results to determine whether these management changes had a statistically significant effect on water quality. Seasonal Hodges-Lehman Estimators (Crawford, et al., 1983) were calculated to measure the magnitude of the effects (Table F-1). Data collected prior to August 1989 were compared to data collected after February to determine whether there was a significant difference between these two datasets. There were insufficient data collected during the intervening period, so step trend results reflect the combined effects of the three management changes. Results show that while ammonia nitrogen concentration decreased, nitrate nitrogen concentrations increased, resulting in no difference in nitrogen subindex scores. As predicted, the BOD and DO subindices improved, likely due to a reduction in reduce nitrogen-related biochemical oxygen demand. Reductions of total phosphorus concentrations led to an improvement in total phosphorus subindex scores of 35 points. Total solids concentrations increased, but the resultant reduction of total subindex scores was small in magnitude, compared to the improvement in the total phosphorus subindex. pH significantly increased, probably because of the increased oxygenation of the water. This change in pH values did not significantly change pH subindex values. Neither temperature nor fecal coliform counts significantly changed. The difference in OWQI values represents an improvement of 33 WQI points, comparable to the 34 point improvement measured over time by the Seasonal-Kendall trend analysis (Figure F-11).

Table F-1. Seasonal Hodges-Lehmann Estimator (Δ_{HL}), Magnitude of Step Trend. Before Period: 10/85-7/89; After Period: 3/91-9/95

Variable	Δ_{HL}	***Variable***	Δ_{HL}
Ammonia, mg/L N	-0.43	Nitrogen Subindex	No Change
Nitrate, mg/L N	+0.30		
BOD, mg/L	-1.0	BOD Subindex	+13
Dissolved Oxygen, % sat.	+8.0	DO Subindex	+5.3
Dissolved Oxygen, mg/L	+1.1		
Total Phosphorus, mg/L P	-0.11	Phosphorus Subindex	+35
Total Solids, mg/L	+10	Total Solids Subindex	-3.6
pH, SU	+0.2	pH Subindex	No Change
Temperature, C	No Change	Temperature Subindex	No Change
Fecal Coliform, #/100 mL	No Change	Fecal Coliform Subindex	No Change
		OWQI	**+33**

Since 1988, general water quality conditions have significantly improved at all of the Tualatin Subbasin sites monitored by DEQ Laboratory. It is important to note that water quality has improved while population has significantly grown at the same time. Water quality trends show that changes in water quality management in the Tualatin basin have proven to be beneficial.

USE AS AN ENVIRONMENTAL INDICATOR

Environmental indicators analyze, describe, and present scientifically-based information on the significance of environmental conditions and trends. They can assist in communicating, consensus building, priority setting, and budgeting in natural resource areas. The OWQI is used as an environmental indicator in the Oregon Benchmarks, published in “Oregon Shines II” (Oregon Progress Board, 1997). Oregon Benchmarks reports statewide trends in areas ranging from the arts to public safety to the economy. In the Benchmark report, “Percentage of stream monitoring sites with improving water quality” is contrasted with “Percentage of stream monitoring sites with decreasing water quality” to measure the relative success of the combined efforts to manage general water quality throughout the state. The OWQI is used as an environmental indicator in the Environmental Partnership Agreement between Oregon DEQ and the US EPA Region 10 (US EPA, 1996; US EPA, 1997). In the agreement, the OWQI is used to monitor the progress of various individual water quality management projects. Portland State University publishes “Portland Today” (PSU Center for Science

Education, 1996), an annual journal promoting awareness of the urban environment in the Portland metropolitan area. "Portland Today" uses the OWQI to indicate conditions and trends in the Willamette River as it flows through Portland.

CONCLUSION

The original OWQI was designed to be a simple and concise method for expressing ambient water quality information. Its use was discontinued due to insufficient resources available for the maintenance of the index and its database. Modern computer technology, better understanding of water quality, and enhanced tools for displaying data now make an improved OWQI feasible. By combining multiple variables into a single score, the present OWQI allows the analyst to study the influences of these variables on general water quality. It is easier to determine, for a given location, which water quality variables are most impacted during various seasons. The OWQI can be used to detect trends over time and compare conditions across river basins. The OWQI indicates impairment of water quality and progress of water quality management practices. Most importantly, the Oregon Water Quality Index improves comprehension of general water quality issues, communicates water quality status, and illustrates the need for and effectiveness of protective practices.

ADDENDUM 1. SUBINDEX (SI) CALCULATION

Temperature (T)

$T \leq 11C$:	$SI_T = 100$
$11C < T \leq 29C$:	$SI_T = 76.54407 + 4.172431*T - 0.1623171*T^2 - 2.055666E-3*T^3$
$29C < T$:	$SI_T = 10$

Dissolved Oxygen (DO)

DO saturation (DOs) ≤ 100%:

DO concentration (DOc) ≤ 3.3 mg l^{-1}:	$SI_{DO} = 10$
3.3 mg/L < DO_C < 10.5 mg/L:	$SI_{DO} = -80.28954 + 31.88249*DO_C - 1.400999*DO_C^2$
10.5 mg/L ≤ DO_C:	$SI_{DO} = 100$

100% < DOs ≤ 275%:	$SI_{DO} = 100 * \exp((DO_S - 100) * -1.197429E-2)$
275% < DOs:	$SI_{DO} = 10$

Biochemical Oxygen Demand, 5-day (BOD)

BOD ≤ 8 mg/L:	$SI_{BOD} = 100 * \exp(BOD * -0.199314)$
8 mg/L < BOD:	$SI_{BOD} = 10$

pH

pH < 4 :	$SI_{pH} = 10$
4 ≤ pH < 7:	$SI_{pH} = 2.628419 * \exp(pH * 0.520025)$
7 ≤ pH ≤ 8:	$SI_{pH} = 100$
8 < pH ≤ 11:	$SI_{pH} = 100 * \exp((pH-8) * -0.5187742)$
11 < pH:	$SI_{pH} = 10$

Total Solids (TS)

Geologically variable - basin specific. See Addendum 2.

Ammonia + Nitrate Nitrogen (N)

N ≤ 3 mg/L:	$SI_N = 100 * \exp(N * -0.460512)$
3 mg/L < N:	$SI_N = 10$

Total Phosphorus (P)

P ≤ 0.25 mg/L:	$SI_P = 100 - 299.5406*P - 0.1384108*P^2$
0.25 mg/L < P:	$SI_P = 10$

Fecal Coliform (FC)

FC ≤ 50 #/100 mL:	$SI_{FC} = 98$
50 #/100 mL < FC ≤ 1600 #/100 mL:	$SI_{FC} = 98 * \exp((FC-50) * -9.917754E-4)$
1600 #/100 mL < FC:	$SI_{FC} = 10$

ADDENDUM 2. BASIN-SPECIFIC TOTAL SOLIDS (TS) SUBINDEX CALCULATION

Coastal Basins

TS ≤ 40 mg/L:	$SI_{TS} = 100$
40 mg/L < TS ≤ 220 mg/L:	$SI_{TS} = 142.62116 * \exp(TS * -8.86166E-3)$
220 mg/L < TS:	$SI_{TS} = 10$

Willamette, Sandy, and Hood Basins

TS ≤ 40 mg/L:	$SI_{TS} = 100$
40 mg/L < TS ≤ 280 mg/L:	$SI_{TS} = 123.43562 * \exp(TS * -5.29647E-3)$
280 mg/L < TS:	$SI_{TS} = 10$

Umpqua Basin

TS ≤ 40 mg/L:	$SI_{TS} = 100$
40 mg/L < TS ≤ 300 mg/L:	$SI_{TS} = 124.69467 * \exp(TS * -5.55213E-3)$
300 mg/L < TS:	$SI_{TS} = 10$

Rogue Basin

TS ≤ 50 mg/L:	$SI_{TS} = 100$
50 mg/L < TS ≤ 350 mg/L:	$SI_{TS} = 127.13859 * \exp(TS * -4.81795E-3)$
350 mg/L < TS:	$SI_{TS} = 10$

Deschutes Basin, excluding Crooked Subbasins

TS ≤ 80 mg/L:	$SI_{TS} = 100$
80 mg/L < TS ≤ 300 mg/L:	$SI_{TS} = 179.48950 * \exp(TS * -7.32601E-3)$
300 mg/L < TS:	$SI_{TS} = 10$

Klamath Basin

TS ≤ 100 mg/L:	$SI_{TS} = 100$
100 mg/L < TS ≤ 450 mg/L:	$SI_{TS} = 144.90986 * \exp(TS * -3.58002E-3)$
450 mg/L < TS:	$SI_{TS} = 10$

John Day, Umatilla, and Grande Ronde Basins, Crooked Subbasins

TS ≤ 100 mg/L:	$SI_{TS} = 100$
100 mg/L < TS ≤ 800 mg/L:	$SI_{TS} = 116.27594 * \exp(TS * -1.49786E-3)$
800 mg/L < TS:	$SI_{TS} = 10$

Powder, Burnt, Malheur, and Owyhee Basins

TS ≤ 200 mg/L:	$SI_{TS} = 100$
200 mg/L < TS ≤ 1600 mg/L:	$SI_{TS} = 116.26522 * \exp(TS * -7.48861E-4)$
1600 mg/L < TS:	$SI_{TS} = 10$

ADDENDUM 3. OREGON WATER QUALITY INDEX (OWQI) CALCULATION

Unweighted Harmonic Square Mean

$$OWQI = \sqrt{\frac{n}{\sum_{i=1}^{n} \frac{1}{SI_i^2}}}$$

=SQRT(8/(1/ SI_T^2+1/ SI_{DO}^2+1/ SI_{BOD}^2+1/ SI_{pH}^2+1/ SI_{TS}^2+1/ SI_N^2+1/ SI_P^2+1/ SI_{FC}^2))

Where: n is number of subindices;
SI_i is subindex i;
SI_T is temperature subindex;
SI_{DO} is dissolved oxygen subindex;
SI_{BOD} is biochemical oxygen demand subindex;
SI_{pH} is pH subindex;
SI_{TS} is total solids subindex;
SI_N is ammonia+nitrate nitrogen subindex;
SI_P is total phosphorus subindex;
and SI_{FC} is fecal coliform subindex.

Classifications

0-59	Very Poor
60-79	Poor
80-84	Fair
85-89	Good
90-100	Excellent

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Appendix G.
RPI DATA

STAID	Site Name	Dates	00010 Water Temperature (degrees)	00400 pH (standard units)	00300 Oxygen Dissolved (MG/L)	Total Solids (MG/L)
10092700	Bear River at Idaho-Utah State Line	19940516	15.2	8.2	7.8	551
10092700	Bear River at Idaho-Utah State Line	19960917	12.4	8.3	8.3	574
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19960906	10.5	6.9	9.3	225
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19970917	11.5	7.1	9.5	190
12419000	Spokane River nr. Post Falls	19940907	20.2	7.6	8.3	42
13056500	Henrys Fork nr. Rexburg	19940913	15.6	7.9	7.6	134
13068500	Blackfoot River nr. Blackfoot	19930521	15	8.4	8.2	591
13068500	Blackfoot River nr. Blackfoot	19960919	11.4	8.4	10.3	221
13069500	Snake River nr. Blackfoot	19940718	20.5	8.5	10.1	212
13073000	Portneuf River near Blackfoot	19960918	11.3	8.1	8	519
13075000	Marsh Creek nr. McCammon	19930524	17	8.2	8.4	470
13075000	Marsh Creek nr. McCammon	19950517	12.4	8.1	7.4	541
13075000	Marsh Creek nr. McCammon	19960918	10.3	7.8	8.5	562
13081500	Snake River nr. Minidoka	19940916	16	8.3	7.6	275
13090000	Snake River nr. Kimberly	19930520	17.5	8.5	9.3	315
13090000	Snake River nr. Kimberly	19950914	18.4	8.3	8.4	285
13092747	Rock Creek above Hwy.30/93 Twin Falls	19960906	14.5	8.4	9.4	480
13094000	Snake River Nr. Buhl	19930514	16.6	8.3	6.8	387
13094000	Snake River Nr. Buhl	19930723	17.8	8.4	9.2	392
13094000	Snake River Nr. Buhl	19950524	14.4	8.5	9.3	438
13094000	Snake River Nr. Buhl	19950718	18.6	8.4	8	344
13094000	Snake River Nr. Buhl	19950906	17.2	8.3	8.3	340
13108150	Salmon Falls Creek nr. Hagerman	19940517	13.6	8.6	11.6	477
13108150	Salmon Falls Creek	19940922	14.7	8.6	12	516

STAID	Site Name	Dates	00010 Water Temperature (degrees)	00400 pH (standard units)	00300 Oxygen Dissolved (MG/L)	Total Solids (MG/L)
	nr. Hagerman					
13108900	Camas Creek at Red Road nr. Kilgore	19970923	10.4	8.1	9	147
13113000	Beaver Creek at Spencer	19970922	10.6	8.6	9.5	260
13152500	Malad River nr. Gooding	19930722	19	8.7	9.1	260
13168500	Bruneau River nr. Hot Springs	19940517	12.4	7.8	11.9	100
13172500	Snake River nr. Murphy	19940520	17.1	8.8	9.9	305
13172500	Snake River nr. Murphy	19940914	18.1	8.6	10.1	318
13206000	Boise River at Glenwood Bridge	19960924	16	8.1	10.7	63
13213000	Boise River nr. Parma	19930513	15.6	8	9.8	188
13213000	Boise River nr. Parma	19930908	18.7	8.5	11.8	321
13213000	Boise River nr. Parma	19940510	18.4	8	8.7	345
13213000	Boise River nr. Parma	19940907	17.2	8.3	12	353
13213000	Boise River nr. Parma	19950719	21	8	8.3	437
13213100	Snake River at Nyssa	19930917	17.9	8.6	11.5	362
13251000	Payette River nr. Payette	19930629	16.3	8	9.4	81
13251000	Payette River nr. Payette	19930825	17.9	8.3	10.9	143
13266000	Weiser River nr. Weiser	19930323	4.9	7.4	11.6	375
13266000	Weiser River nr. Weiser	19930517	12.4	7.8	10.5	131
13266000	Weiser River nr. Weiser	19930915	18	8.7	11.4	110
13269000	Snake River at Weiser	19930916	18.1	8.7	10.3	336
13302005	Pahsimeroi River at Ellis	19950608	8.7	8.1	9.7	233
13302500	Salmon River at Salmon	19950607	6.3	7.4	10.1	215
13338500	South Fork Clearwater River at Stites	19930512	10.5	7.5	11	98
13342450	Lapwai Creek nr. Lapwai	19930317	5	7.8	11.7	152
13342450	Lapwai Creek nr. Lapwai	19930512	18.8	8	8.6	152
13342450	Lapwai Creek nr. Lapwai	19930910	15	8.3	13.4	194
13342450	Lapwai Creek nr.	19950315	8.3	7.8	11.6	396

STAID	Site Name	Dates	00010 Water Temperature (degrees)	00400 pH (standard units)	00300 Oxygen Dissolved (MG/L)	Total Solids (MG/L)
	Lapwai					
13342450	Lapwai Creek nr. Lapwai	19970910	15	7.8	9.6	248
13345000	Palouse River nr. Potlatch	19930525	16.9	7.4	9.9	68

STAID	Site Name	Dates	31625 Coliform Fecal 0 cols./100 ML	Total Nitrogen (MG/L as N)	00665 Phosphorus Total (MG/L as P)	Temperature Sub-index score
10092700	Bear River at Idaho-Utah State Line	19940516	210	0.109	0.04	93.48476417
10092700	Bear River at Idaho-Utah State Line	19960917	140	0.22	0.02	98.44973539
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19960906	220	0.44	0.04	100
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19970917	26	0.276	0.035	99.17221825
12419000	Spokane River nr. Post Falls	19940907	54	0.25	0.02	73.52225168
13056500	Henrys Fork nr. Rexburg	19940913	61	0.15	0.02	92.42634361
13068500	Blackfoot River nr. Blackfoot	19930521	300	0.25	0.07	93.980445
13068500	Blackfoot River nr. Blackfoot	19960919	150	0.16	0.03	99.2272374
13069500	Snake River nr. Blackfoot	19940718	180	0.061	0.04	71.83917824
13073000	Portneuf River near Blackfoot	19960918	110	0.9	0.02	99.27726146
13075000	Marsh Creek nr. McCammon	19930524	150	0.4	0.06	88.00486752
13075000	Marsh Creek nr. McCammon	19950517	720	0.37	0.13	98.44973539
13075000	Marsh Creek nr. McCammon	19960918	620	0.74	0.06	100
13081500	Snake River nr. Minidoka	19940916	66	0.13	0.06	91.27769304
13090000	Snake River nr. Kimberly	19930520	38	0.42	0.04	86.14988344
13090000	Snake River nr. Kimberly	19950914	22	0.61	0.08	82.43598093
13092747	Rock Creek above Hwy.30/93 Twin Falls	19960906	350	2.03	0.08	95.12283713
13094000	Snake River Nr. Buhl	19930514	230	1.53	0.16	89.38338831
13094000	Snake River Nr. Buhl	19930723	220	1.36	0.11	84.96584569
13094000	Snake River Nr. Buhl	19950524	88	0.31	0.17	95.33484229
13094000	Snake River Nr. Buhl	19950718	44	1.24	0.07	81.54430514
13094000	Snake River Nr. Buhl	19950906	140	1.32	0.09	87.28054367
13108150	Salmon Falls Creek nr. Hagerman	19940517	56	2.11	0.04	96.83578145

STAID	Site Name	Dates	31625 Coliform Fecal 0 cols./100 ML	Total Nitrogen (MG/L as N)	00665 Phosphorus Total (MG/L as P)	Temperature Sub-index score
13108150	Salmon Falls Creek nr. Hagerman	19940922	50	2.31	0.04	94.68239957
13108900	Camas Creek at Red Road nr. Kilgore	19970923	88	0.091	0.066	100
13113000	Beaver Creek at Spencer	19970922	54	0.09	0.017	100
13152500	Malad River nr. Gooding	19930722	200	0.08	0.07	79.68763596
13168500	Bruneau River nr. Hot Springs	19940517	37	0.098	0.03	98.44973539
13172500	Snake River nr. Murphy	19940520	27	0.69	0.11	87.64564033
13172500	Snake River nr. Murphy	19940914	54	0.94	0.04	83.72801624
13206000	Boise River at Glenwood Bridge	19960924	45	0.3	0.1	91.27769304
13213000	Boise River nr. Parma	19930513	590	0.96	0.2	92.42634361
13213000	Boise River nr. Parma	19930908	260	1.92	0.28	81.08932556
13213000	Boise River nr. Parma	19940510	1000	1.75	0.46	82.43598093
13213000	Boise River nr. Parma	19940907	330	1.82	0.3	87.28054367
13213000	Boise River nr. Parma	19950719	270	1.68	0.21	68.90603064
13213100	Snake River at Nyssa	19930917	240	1.23	0.07	84.55923318
13251000	Payette River nr. Payette	19930629	380	0.18	0.02	90.35640108
13251000	Payette River nr. Payette	19930825	180	0.38	0.05	84.55923318
13266000	Weiser River nr. Weiser	19930323	120	1.45	0.15	100
13266000	Weiser River nr. Weiser	19930517	200	0.17	0.12	98.44973539
13266000	Weiser River nr. Weiser	19930915	100	0.26	0.13	84.14662848
13269000	Snake River at Weiser	19930916	220	1.13	0.06	83.72801624
13302005	Pahsimeroi River at Ellis	19950608	1100	0.27	0.07	100
13302500	Salmon River at Salmon	19950607	130	0.09	0.11	100
13338500	South Fork Clearwater River at Stites	19930512	100	0.102	0.07	100
13342450	Lapwai Creek nr. Lapwai	19930317	110	5.83	0.18	100
13342450	Lapwai Creek nr. Lapwai	19930512	520	0.89	0.14	80.62823106

STAID	Site Name	Dates	31625 Coliform Fecal 0 cols./100 ML	Total Nitrogen (MG/L as N)	00665 Phosphorus Total (MG/L as P)	Temperature Sub-index score
13342450	Lapwai Creek nr. Lapwai	19930910	39	0.45	0.09	93.980445
13342450	Lapwai Creek nr. Lapwai	19950315	89	3.12	0.38	100
13342450	Lapwai Creek nr. Lapwai	19970910	89	2.446	0.091	93.980445
13345000	Palouse River nr. Potlatch	19930525	200	0.11	0.07	88.3582405 7

STAID	Site Name	Dates	D.O. Sub-index Score	pH Sub-index Score	Total Solids Sub-index Score	Total Nitrogen Sub-index Score
10092700	Bear River at Idaho-Utah State Line	19940516	83.21180408	90.14462689	50.93983851	95.10431844
10092700	Bear River at Idaho-Utah State Line	19960917	87.88224489	85.58738716	49.2148063	90.36504714
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19960906	95.12297665	101.855488	83.00888576	81.65841745
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19970917	96.23509903	100	87.47672512	88.06444482
12419000	Spokane River nr. Post Falls	19940907	87.88224489	100	100	89.12520563
13056500	Henrys Fork nr. Rexburg	19940913	81.14761378	100	95.13081262	93.32550033
13068500	Blackfoot River nr. Blackfoot	19930521	87.00416072	81.26053757	47.97743995	89.12520563
13068500	Blackfoot River nr. Blackfoot	19960919	99.56350861	81.26053757	83.50772139	92.89671327
13069500	Snake River nr. Blackfoot	19940718	98.8994182	77.15243082	84.64108943	97.22996579
13073000	Portneuf River near Blackfoot	19960918	85.1639864	94.94452427	53.44092399	66.06964322
13075000	Marsh Creek nr. McCammon	19930524	88.73232706	90.14462689	57.51075417	83.17654408
13075000	Marsh Creek nr. McCammon	19950517	78.97141548	94.94452427	51.70858901	84.33363237
13075000	Marsh Creek nr. McCammon	19960918	89.55440723	100	50.10740689	71.12161549
13081500	Snake River nr. Minidoka	19940916	81.14761378	85.58738716	77.01919368	94.1890211
13090000	Snake River nr. Kimberly	19930520	95.12297665	77.15243082	72.54015418	82.41398521
13090000	Snake River nr. Kimberly	19950914	88.73232706	85.58738716	75.87415096	75.50945393
13092747	Rock Creek above Hwy.30/93 Twin Falls	19960906	95.69303884	81.26053757	56.65574301	39.26489356
13094000	Snake River Nr. Buhl	19930514	71.77077262	85.58738716	65.12407779	49.43144825
13094000	Snake River Nr. Buhl	19930723	94.52491246	81.26053757	64.63816588	53.4568008
13094000	Snake River Nr. Buhl	19950524	95.12297665	77.15243082	60.3344638	86.69632245
13094000	Snake River Nr. Buhl	19950718	85.1639864	81.26053757	69.45661544	56.49404905
13094000	Snake River Nr. Buhl	19950906	87.88224489	85.58738716	69.87400973	54.45062599
13108150	Salmon Falls Creek nr. Hagerman	19940517	100	73.2520084	56.91090298	37.84465922

STAID	Site Name	Dates	D.O. Sub-index Score	pH Sub-index Score	Total Solids Sub-index Score	Total Nitrogen Sub-index Score
13108150	Salmon Falls Creek nr. Hagerman	19940922	100	73.2520084	53.68160542	34.51477406
13108900	Camas Creek at Red Road nr. Kilgore	19970923	93.2447781	94.94452427	93.29632699	95.89593509
13113000	Beaver Creek at Spencer	19970922	96.23509903	73.2520084	78.76923953	95.94010649
13152500	Malad River nr. Gooding	19930722	93.89884628	69.5487709	78.76923953	96.38294106
13168500	Bruneau River nr. Hot Springs	19940517	100	100	100	95.5873042
13172500	Snake River nr. Murphy	19940520	98.1233198	66.03274966	73.63488242	72.77823247
13172500	Snake River nr. Murphy	19940914	98.8994182	73.2520084	72.21492048	64.86374935
13206000	Boise River at Glenwood Bridge	19960924	100	94.94452427	100	87.09649013
13213000	Boise River nr. Parma	19930513	97.6932676	100	87.73917381	64.26908137
13213000	Boise River nr. Parma	19930908	100	77.15243082	71.89114496	41.3051482
13213000	Boise River nr. Parma	19940510	91.11456157	100	69.35265703	44.66875152
13213000	Boise River nr. Parma	19940907	100	85.58738716	68.52657179	43.25177816
13213000	Boise River nr. Parma	19950719	87.88224489	100	60.42490409	46.13214641
13213100	Snake River at Nyssa	19930917	100	73.2520084	67.60898168	56.75481088
13251000	Payette River nr. Payette	19930629	95.69303884	100	100	92.04504032
13251000	Payette River nr. Payette	19930825	100	85.58738716	93.85698423	83.94615874
13266000	Weiser River nr. Weiser	19930323	100	100	66.30522214	51.28651161
13266000	Weiser River nr. Weiser	19930517	100.115591	100	95.55925243	92.46989629
13266000	Weiser River nr. Weiser	19930915	100	69.5487709	98.6128482	88.71571696
13269000	Snake River at Weiser	19930916	99.56350861	69.5487709	70.29391232	59.42955289
13302005	Pahsimeroi River at Ellis	19950608	97.23521341	94.94452427	82.0201361	88.3081097
13302500	Salmon River at Salmon	19950607	98.8994182	100	84.26160119	95.94010649
13338500	South Fork Clearwater River at Stites	19930512	100	100	100	95.41138987
13342450	Lapwai Creek nr. Lapwai	19930317	100	100	92.60021277	10
13342450	Lapwai Creek nr. Lapwai	19930512	90.3484854	100	92.60021277	66.37460351

STAID	Site Name	Dates	D.O. Sub-index Score	pH Sub-index Score	Total Solids Sub-index Score	Total Nitrogen Sub-index Score
13342450	Lapwai Creek nr. Lapwai	19930910	100	85.58738716	86.95418053	81.28323518
13342450	Lapwai Creek nr. Lapwai	19950315	100	100	64.25204804	10
13342450	Lapwai Creek nr. Lapwai	19970910	96.74915722	100	80.19786386	32.41942674
13345000	Palouse River nr. Potlatch	19930525	98.1233198	100	100	95.06053184

STAID	Site Name	Dates	Total Phosphorus Sub-index Score	Fecal Coliform Sub-Index Score	RPI Score	Total Phosphorus Sub-index Score
10092700	Bear River at Idaho-Utah State Line	19940516	88.01815454	83.62005759	78.0211239	88.01815454
10092700	Bear River at Idaho-Utah State Line	19960917	94.00913264	89.63157816	78.28764542	94.00913264
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19960906	88.01815454	82.79483338	89.34267365	88.01815454
12413470	South Fork Coeur d'Alene River nr. Pinehurst	19970917	89.51590945	98	93.64697538	89.51590945
12419000	Spokane River nr. Post Falls	19940907	94.00913264	97.61199418	90.29968585	94.00913264
13056500	Henrys Fork nr. Rexburg	19940913	94.00913264	96.93667684	92.74451535	94.00913264
13068500	Blackfoot River nr. Blackfoot	19930521	79.03147979	76.47956865	73.71631796	79.03147979
13068500	Blackfoot River nr. Blackfoot	19960919	91.01365743	88.74702784	90.17488793	91.01365743
13069500	Snake River nr. Blackfoot	19940718	88.01815454	86.14540951	84.81037683	88.01815454
13073000	Portneuf River near Blackfoot	19960918	94.00913264	92.33847987	77.68403464	94.00913264
13075000	Marsh Creek nr. McCammon	19930524	82.02706572	88.74702784	79.71204465	82.02706572
13075000	Marsh Creek nr. McCammon	19950517	61.05738286	50.42453997	67.18928747	61.05738286
13075000	Marsh Creek nr. McCammon	19960918	82.02706572	55.68192014	70.91803963	82.02706572
13081500	Snake River nr. Minidoka	19940916	82.02706572	96.45716968	86.02974077	82.02706572
13090000	Snake River nr. Kimberly	19930520	88.01815454	98	84.35530677	88.01815454
13090000	Snake River nr. Kimberly	19950914	76.03586617	98	82.16544603	76.03586617
13092747	Rock Creek above Hwy.30/93 Twin Falls	19960906	76.03586617	72.77953905	64.29990721	76.03586617
13094000	Snake River Nr. Buhl	19930514	52.06996068	81.97775309	65.76493209	52.06996068
13094000	Snake River Nr. Buhl	19930723	67.04885923	82.79483338	71.75659116	67.04885923
13094000	Snake River Nr. Buhl	19950524	49.07409793	94.37535918	72.71723351	49.07409793
13094000	Snake River Nr. Buhl	19950718	79.03147979	98	75.6070284	79.03147979
13094000	Snake River Nr. Buhl	19950906	73.04022487	89.63157816	74.79473833	73.04022487
13108150	Salmon Falls Creek nr. Hagerman	19940517	88.01815454	97.41856773	65.443531	88.01815454

STAID	Site Name	Dates	Total Phosphorus Sub-index Score	Fecal Coliform Sub-Index Score	RPI Score	Total Phosphorus Sub-index Score
13108150	Salmon Falls Creek nr. Hagerman	19940922	88.01815454	98	62.05881335	88.0181545 4
13108900	Camas Creek at Red Road nr. Kilgore	19970923	80.22971748	94.375359 18	92.5513449	80.2297174 8
13113000	Beaver Creek at Spencer	19970922	94.9077698	97.611994 18	89.1818823	94.9077698
13152500	Malad River nr. Gooding	19930722	79.03147979	84.453506 89	81.775967	79.0314797 9
13168500	Bruneau River nr. Hot Springs	19940517	91.01365743	98	97.42674069	91.0136574 3
13172500	Snake River nr. Murphy	19940520	67.04885923	98	77.57584525	67.0488592 3
13172500	Snake River nr. Murphy	19940914	88.01815454	97.611994 18	79.96471795	88.0181545 4
13206000	Boise River at Glenwood Bridge	19960924	70.04455589	98	89.66185399	70.0445558 9
13213000	Boise River nr. Parma	19930513	40.08634357	57.363531 56	65.73323414	40.0863435 7
13213000	Boise River nr. Parma	19930908	10	79.574575 99	24.8259258	10
13213000	Boise River nr. Parma	19940510	10	38.197911 78	24.39536754	10
13213000	Boise River nr. Parma	19940907	10	74.237570 77	24.89272594	10
13213000	Boise River nr. Parma	19950719	37.09037008	78.789275 56	58.12582886	37.0903700 8
13213100	Snake River at Nyssa	19930917	79.03147979	81.168736 35	74.31978846	79.0314797 9
13251000	Payette River nr. Payette	19930629	94.00913264	70.646007 51	90.04997672	94.0091326 4
13251000	Payette River nr. Payette	19930825	85.02262397	86.145409 51	87.95355307	85.0226239 7
13266000	Weiser River nr. Weiser	19930323	55.06579576	91.427215 86	71.82054349	55.0657957 6
13266000	Weiser River nr. Weiser	19930517	64.05313488	84.453506 89	87.54507837	64.0531348 8
13266000	Weiser River nr. Weiser	19930915	61.05738286	93.258826 54	81.22231886	61.0573828 6
13269000	Snake River at Weiser	19930916	82.02706572	82.794833 38	75.43052712	82.0270657 2
13302005	Pahsimeroi River at Ellis	19950608	79.03147979	34.591338 16	66.36370899	79.0314797 9
13302500	Salmon River at Salmon	19950607	67.04885923	90.524944 87	88.378654	67.0488592 3
13338500	South Fork Clearwater River at Stites	19930512	79.03147979	93.258826 54	94.43497974	79.0314797 9
13342450	Lapwai Creek nr. Lapwai	19930317	46.07820749	92.338479 87	25.22064304	46.0782074 9
13342450	Lapwai Creek nr. Lapwai	19930512	58.06160315	61.487447 03	73.92005999	58.0616031 5

STAID	Site Name	Dates	Total Phosphorus Sub-index Score	Fecal Coliform Sub-Index Score	RPI Score	Total Phosphorus Sub-index Score
13342450	Lapwai Creek nr. Lapwai	19930910	73.04022487	98	86.99566132	73.04022487
13342450	Lapwai Creek nr. Lapwai	19950315	10	94.28180642	18.40938552	10
13342450	Lapwai Creek nr. Lapwai	19970910	72.74065922	94.28180642	63.63801669	72.74065922
13345000	Palouse River nr. Potlatch	19930525	79.03147979	84.45350689	91.12885597	79.03147979

Glossary

Note:
This glossary is intended to define terms in the context used in the Idaho Rivers Ecological Assessment Framework.

Term	**Definition**
Ambient	General conditions in the environment. In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations, or specific disturbances such as a wastewater outfall (Armantrout 1998, EPA 1996).
Anthropogenic	Made by humans. Includes waterways such as canals, flumes, ditches, and similar structures constructed for the purpose of water conveyance.
Aquatic	Plant or animal life living in, growing in, or adapted to water.
Assemblage (aquatic)	An association of interacting populations of organisms in a given water body, for example, a fish assemblage or a benthic macroinvertebrate assemblage (see also community) (EPA 1996).
Attribute	A biological characteristic or feature of an assemblage; for example, motile diatoms or piscivorous fish or invertebrates that cling.
Autecological guild	A group of species (usually algae) that share an ecological feature, such as tolerance of high nutrients.
Average depth at baseflow	This is an average of all the depth measurements taken at a site (n=approximately 60). These measurements are taken at the transects where macroinvertebrates are sampled. Similar to average width, this criterion assesses conditions during baseflow, but does not necessarily consider water flow regulations.
Average greatest depth	This is an average of the three greatest depths in the reach.
Average width at baseflow	This criterion is a measure of water conditions during baseflow when BURP sampling occurs. This is the average wetted width of all measurements taken at the site (n=6). Average width does not discern the difference in water body size due to diversions or other water flow regulations.

Term	Definition
Beneficial Use Reconnaissance Program (BURP)	Systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address wadeable streams and small rivers, large rivers, and lakes and reservoirs.
Beneficial use	Any of the various uses that may be made of water, including, but not limited to, aquatic biota, recreation in or on the water, water supply, wildlife habitat, and aesthetics.
Benthic	Located on or near the bottom of the stream bed.
Best professional judgment	An option arrived at by a trained and/or technically competent individual when he/she applies interpretation and synthesizes information to derive a conclusion and/or interpretation.
Bias	The error caused by systematic deviation of an estimate from the true value (Suter 1993).
Biochemical oxygen demand (BOD)	(1) The dissolved oxygen required to oxidize inorganic chemicals in water. (2) A measure of oxygen consumption during a fixed period of time. (3) the amount (milligram per liter) of molecular oxygen required to stabilize decomposable organic matter by aerobic biochemical action.
Biological integrity	(1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). (2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).
Biota	The animal and plant life of a given region.
Biotic community	A naturally-occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent.
Candidate metric	An attribute of the biological assemblage that has been proposed, but not tested for its association with human disturbance.
Catchment area	The area draining into a river, stream, lake or other water body.
Cold water fishes	A broad term applied to fish species that inhabit waters with relatively cold temperatures (optimum temperatures generally between 4-15EC [40-60EF]). Examples are salmon, trout, chars, and whitefish (Armantrout 1998).

Term	Definition
Coliform	A group of bacteria found in the intestines of warm-blooded animals (including humans) and in plants, soil, air, and water. Fecal coliform are a specific class of bacteria which only inhibit the intestines of warm-blooded animals. The presence of coliform is an indication that the water is polluted and may contain pathogenic organisms.
Community (aquatic)	An association of interacting assemblages in a given water body, the biotic component of an ecosystem (see also assemblage) (EPA 1996).
Cool water fishes	A broad term applied to fish species that inhabit waters with relatively cool temperatures (optimum temperatures generally between 10-21EC [50-70EF]) (Armantrout 1998).
Cottid	
Criteria	Descriptive factors taken into account by EPA in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. When issued by EPA, the criteria provide guidance to the states on how to establish their standards.
Cyanobacteria	Blue green algae.
Designated uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Diatom	Single-celled algae with a silica
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved oxygen (DO)	The oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. DO levels are considered an important indicator of a water body's ability to support desirable aquatic life.
Disturbance	Any event or series of events that disrupt ecosystem, community, or population structure and alters the physical environment.
Diversity	Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems within a geographic location.

Term	Definition
Ecological indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of biotic or abiotic variable, that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability.
Ecological integrity	(1) A living system exhibits integrity if, when subjected to disturbance, it sustains and organizes a self-correcting ability to recover toward a biomass end-state that is normal for that system. End-states other than the pristine or naturally whole may be accepted as abnormal but good. (2) The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).
Ecosystem	The interacting system of a biological community and its non-living environmental surroundings.
Endangered species	Animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (man□caused) or other natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act.
Euhalobus	Prefers or tolerates high concentrations of chloride.
Euthermal	Prefers or tolerates high temperatures.
Eutrophic	High nutrients, typically derived from nonorganic sources.
Exceedance	Violation of the pollutant levels permitted by environmental protection standards.
Exotic species	A species that is not indigenous to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
Fecal coliform bacteria	Bacteria found in the intestinal tracts of mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens.
Fully supporting of cold water biota	Reliable data indicate functioning, sustainable biological assemblages (e.g., fish, macroinvertebrates, or algae) none of which have been modified significantly beyond the natural range of reference conditions (EPA 1995).
Grab sample	A single sample collected at a particular time and place which represents the composition of the water only at that time and place.
Guild	Group of species that share some ecological feature.

Term	Definition
Habitat	The place where a population (e.g., human, animal, plant, microorganism) lives and its surroundings, both living and non-living.
Human made	Relating to or resulting from the influence of human beings on nature; anthropogenic.
Indicator	(1) In biology, any biological entity, process, or community whose characteristics show the presence of specific environmental conditions. (2) In chemistry, a substance that shows a visible change, usually of color, at a desired point in a chemical reaction. (3) A device that indicates the result of a measurement; e.g., a pressure gage or a moveable scale.
Lotic	Fast moving waters, e.g., rivers or streams. Contrast with *lentic* which means still or slow and refers to lakes.
Macroinvertebrate	An invertebrate animal (without backbone) large enough to be seen without magnification and retained by a 0.595 mm (US #30) screen.
Major criteria exceedance	A violation of water quality standards or criteria sufficient in magnitude, frequency, or duration to adversely affect a beneficial use.
Metric	One discrete measure of an ecological indicator (e.g., number of distinct taxon).
Mean annual site discharge	Similar to the site discharge, the mean annual site discharge is determined using data from nearby USGS gaging stations and a similar extrapolation technique.
Metric	A biological attribute or characteristic that is reliably (in terms of statistics) and meaningfully (in terms of underlying biological processes) associated with human degradation.
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.
Morphological guild	Group of diatoms that have similar growth forms.
Non-point sources	Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common non-point sources are agriculture, forestry, cities, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Term	Definition
Not fully supporting of cold water biota	At least one biological assemblage has been significantly modified beyond the natural range of its reference condition (EPA 1995).
Nutrient	Any substance assimilated by living things that promotes growth. In water, the term is generally applied to nitrogen and phosphorus, but is also applied to other essential and trace elements and organic carbon.
Oligosaprobic	Low nutrients and high oxygen.
Oligotrophic	A body of water with low levels of nutrients.
Organic matter	(1) In the ecology of running waters, organic matter, either as a mass or elemental carbon, relates to potential sources and fates of energy in an ecosystem. Organic matter may be classified as being dissolved organic matter, different size classifications of particulate organic carbon, or larger organic debris (Minshall 1996). (2) Carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system (e.g., temperature, pressure, and density are parameters of the atmosphere).
Pathogens	Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals, and plants.
Periphyton	Attached microflora growing on the bottom of a water body, or on other submerged substrates, including higher plants. Epilithic periphyton is flora growing on the surface of rock or stones.
pH (pronounce as separate letters)	pH is an expression of the intensity of the basic or acid condition of a liquid. Mathematically, pH is the logarithm (base 10) of the reciprocal of the hydrogen ion concentration, [H+]. pH= Log (I/[H+]). The pH may range from 0 to 14, where 0 is most acidic, 14 most basic, and 7 neutral.
Phosphorus	An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies. Increased phosphorus levels result from discharge of phosphorus-containing materials into surface waters.

Term	Definition
Physicochemical	In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeably with the term physical/chemical or physiochemical.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	Generally, the presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and health effects. Under the Clean Water Act, for example, the term has been defined as the human-made or human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Polysaprobic	High nutrients and low oxygen associated with organic waste.
Population at risk	A population subgroup that is more likely to be exposed to a chemical, or is more sensitive to the chemical, than is the general population.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type or direction, as opposed to size, magnitude, or degree.
Quantitative	Descriptive of size, magnitude, or degree.
Reconnaissance	An exploratory or preliminary survey of an area.
Reference	A physical or chemical quantity whose value is known, and thus is used to calibrate or standardize instruments.

Term	Definition
Reference condition	(1) A condition that fully supports applicable beneficial uses, with little effect from human activity and representing the highest level of support attainable. (2) The benchmarks for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. Reference conditions can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Reference site	A specific locality on a water body which is minimally impaired and is representative of the expected ecological integrity of other localities on the same water body or nearby water bodies (EPA 1996).
Representative sample	A portion of material or water that is as nearly identical in content and consistency as possible to that in the larger body of material or water being sampled.
River	A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels. See Chapter 2 for water body size criteria.
Secondary drinking water standards	Non-enforceable federal guidelines regarding cosmetic effects (i.e., tooth or skin discoloration) or aesthetic effects (i.e., taste, odor, or color) of drinking water.
Sediments	Fragmented material from weathered rocks and organic material that is suspended in, transported by, and eventually deposited by water or air.
Signal to noise ratio (S/N)	A comparison of the variance among streams (“signal”) with the variance between repeat stream visits (measurement “noise”). Higher S/N indicates better precision. Higher precision means that measures at different stream sites are more different repeat measures at the same sites.
Site discharge	This is the discharge measured, either by the crew or by a nearby gaging station, on the sampling day
Site drainage area	This criterion, which measures the drainage area above the site, is calculated using GIS hydrography (1:100,000) and Hydrologic unit codes (HUC) (4^{th} and 5^{th} field) coverages.
Species	(1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. (2) An organism belonging to such a category.

Term	Definition
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stratification	Separating into layers.
Stream	natural water course containing flowing water, at least part of the year, together with dissolved and suspended materials, that normally supports communities of plants and animals within the channel and the riparian vegetation zone. See Chapter 2 for water body size criteria.
Stream order	Hierarchical ordering of streams based on the degree of branching. A 1^{st}-order stream is an unforked or unbranched stream. Two 1^{st} -order streams flow together to form a 2^{nd}-order stream, two 2^{nd} orders combine to make a 3^{rd}-order stream, etc. (Strahler 1957).
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.
Taxon	Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).
Trophic state	Refers to the concentrations of inorganic nutrients, particularly nitrogen and phosphorus, in a water body.
Turbidity	A measurement used to indicate the clarity of water. Technically, turbidity is an optical property of the water based on the amount of light reflected by suspended particles. Turbidity cannot be directly equated to suspended solids because white particles reflect more light than dark-colored particles and many small particles will reflect more light than an equivalent large particle.
Valve	Diatoms are shaped like small boxes, they have a hard top and a bottom made of silica. Each part is called a valve. The two parts together make up the frustule.
Warm water fishes	A broad term applied to fish species that inhabit waters with relatively cool temperatures (optimum temperatures generally between 15-27EC [60-80EF]) (Armantrout 1998).
Water body	A homogeneous classification that can be assigned to rivers, lakes, estuaries, coastlines, or other water features.
Water quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Term	Definition
Water quality criteria	Levels of water quality expected to render a body of water suitable for its designated use. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Standards	State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.
Watershed	The land area that drains into a stream. An area of land that contributes runoff to one specific delivery point; large watersheds may be composed of several smaller "subwatersheds" each of which contributes runoff to different locations that ultimately combine at a common delivery point.

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